EXAMINING THE EFFECTS OF MODE OF DELIVERY OF A READING FLUENCY INTERVENTION USING A RANDOMIZED EXPERIMENTAL ALTERNATIVE-TREATMENTS DESIGN

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A Dissertation Presented

by

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Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2017

Education

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DEDICATION

To my family.

ACKNOWLEDGEMENTS

I would like to extend my gratitude to those who have made this project possible. Thank you to Read Naturally for allowing me to access the Read Naturally and Read Live materials. Also thank you to Colleen Boyle and Katsiaryna Aniskovich for assisting with implementing the intervention, along with my school partners, especially Amy, Mary Beth, Kira and Sal. I am very grateful to Group 2, including Mac Furey, Mandi Kern and Amadee Mayer for helping with progress monitoring. Also, thanks to my writing team, Mac, Brooke and Mandi for the support in getting through this project. I would also like to thank Craig Wells for his statistical assistance. Thank you to Mary Lynn Boscardin for your extensive advice and guidance along the way.

I would like to express my appreciation for the support and guidance that my committee members John Hintze, Jill Hoover and my advisor Amanda Marcotte have provided. Thank you for your time, feedback, guidance and advice throughout this process. I would like to thank Amanda for the support, guidance and mentorship she has provided throughout the last several years. Amanda, thank you for always pushing me while providing support as I learned that I too, can do “hard things”.

To my parents, Jeff and Amy, and my sister, Stephanie, you have always been a constant source of supportive. Also thank you to my grandparents, Annie, Grandma and Grandpa, and all of my extended family, especially Uncle Timmy. Thank you for the overwhelming support. I am so lucky to have all of you, and you help made this journey possible.

ABSTRACT

EXAMINING THE EFFECTS OF MODE OF DELIVERY OF A READING FLUENCY INTERVENTION USING A RANDOMIZED EXPERIMENTAL ALTERNATIVE-TREATMENTS DESIGN

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The importance of reading fluency has been established. Requirements under the Elementary and Secondary Education Act include increased expectations to utilize evidence based interventions and the expectation of accountability for all students and schools to improve. Teachers are facing challenges trying to incorporate researching findings into their classroom practice while meeting the needs of their students and dealing with limited resources. Advances in computer, literacy and communication technology have resulted in the development of new possibilities for intervention. With districts facing these pressures, it is important to explore the relationship between method of delivery of interventions and outcomes so schools can make informed decisions. This study examined whether the delivery method of a multi-component reading fluency

intervention (traditional vs. computer-led) made a difference in helping to effectively increase oral reading fluency (ORF) of third grade students who were identified as at risk. Read Naturally was chosen as the intervention system for this study as it is supported in the research, is a package often utilized by schools, and offers several methods of delivery. Among their products, they offer both a traditional package (led by teacher and/or audio CD), and a web-based cloud product that is a computer facilitated version of the same intervention. These products have not been compared. A randomized experimental repeated measures design was used to test whether method of delivery of the intervention effected rate of improvement (ROI) in ORF for students. Results indicate that while there was no difference in ROI for students based on group, students in the computerized intervention group had significantly higher gain scores than students in the traditional format group. The computer-facilitated intervention also resulted in greater ease of implementation. There were no differences among generalized outcome measures and measures of student engagement.

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CHAPTER 1

INTRODUCTION, BACKGROUND, AND PURPOSE

Introduction

According to the National Assessment of Educational Progress (NAEP) Nation's Report Card from 2013, only 34% of public school students performed at or above proficient in reading at both grades 4 and 8. As of 2015, 36% of fourth grade and 34% of eighth grade students performed at or above proficient (NAEP, n.d.). Children who read proficiently by the end of third grade are more likely to graduate from high school and be economically stable and successful in adulthood. Third grade marks a pivotal developmental juncture when children transition from learning to read, to reading to learn (Annie E. Casey Foundation, 2013; Chall, 1983). This transition depends upon the effective acquisition of text reading fluency.

It has been established that reading fluency, including both rate and accuracy, serves as a necessary skill for successful readers (Adams, 1990; Hasbrouck, Ihnot & Rogers, 1999; National Reading Panel, 2000). The National Reading Panel found that there are five major components of effective reading instruction that contribute to reading development: phonemic awareness, phonics, fluency, vocabulary, and comprehension (2000). The Panel also reported that reading fluency, defined as the ability to read with speed, accuracy and prosody, is a necessary skill to be developed for both struggling and proficient readers (2000). When students lack effective reading fluency: they are slow to produce words, tend to stammer often, may ignore punctuation and often use flat expression (Hasbrouck et al., 1999). The combination of stumbling over words, reading slowly, and articulating fractured sentence structures leads to difficulty understanding the

overall meaning of what students are reading (Allington, 1983; Biancarosa & Cummings, 2015; Carnine, Silbert & Kameenui, 1997; Hasbrouck et al., 1999; Reutzel & Hollingsworth, 1993). Evidence-based instruction and interventions that promote reading skills, including reading fluency, are essential to promoting successful readers.

Reading fluency includes three components – reading rate, accuracy and prosody (Hudson, Lane & Pullen, 2005). Rate is defined as the number of words read per minute, accuracy is the percent of words read correctly, and prosody is the use of appropriate expression (Cooper, Chard and Kiger, 2006; Hudson et al., 2000; Torgesen & Hudson, 2006). Rate is represented by reading speed; however, it is important to note that this is an outcome of automaticity, not the cause of automaticity (Rasinski, 2014). Automaticity can be defined as the ability to decode words automatically and accurately (Rasinski, 2014). If a student cannot automatically identify words as they read, and has to expend cognitive energy decoding words, it slows the student down, diverts cognitive attention away from text meaning and makes comprehension difficult. If a student makes frequent errors or guesses at words which may occur when focusing on speed, accuracy is sacrificed and comprehension is affected. The National Reading Panel (2000) defined reading fluency as the ability to read orally with speed, accuracy and proper expression that permit a reader to construct the meaning of the text, or comprehend.

LaBerge and Samuels (1974) proposed a theory of reading development that provided a model for thinking about the cognitive processes involved in decoding and comprehension. They purported that people have a finite amount of cognitive attention to accomplish both decoding and comprehension, and when attention is used up for one task, it cannot be applied to another (LaBerge & Samuels, 1974). Even if readers are

decoding words accurately but have to use an excessive amount of cognitive attention to do so, the amount of attention available for comprehension is sacrificed (LaBerge & Samuels, 1974). When a student is not fluent in reading, he or she has to alternate attention between decoding and constructing meaning; when decoding there is not much attention left for constructing meaning, but if the attention is on constructing meaning, accurate word recognition and decoding falter (Cooper et al., 2006). When decoding and word recognition becomes automatic, students can devote cognitive attention to meaning, improving comprehension.

There are several research-supported strategies for improving fluency that are found in the literature including: reading with a model/listening to fluent reading; repeated readings of the same text; and progress monitoring with feedback (Hasbrouck et al., 1999). Listening to fluent reading or listening-while-reading is an intervention that involves the student reading a passage, either aloud or silently, while the text is read by a fluent model (either in person or via an audio device) (Hawkins, Marsicano, Schimitt, McCallum & Musti-Rao, 2015). Repeated reading involves the student rereading passages while correcting errors until they achieve a set level of accuracy and fluency (Hawkins et al., 2015). Progress monitoring involves tracking and being aware of the student's progress, along with feedback which includes involving the student in the process.

These strategies have shown to be evidence-based practices for improving fluency (Hawkins et al., 2015). Skinner, Cooper and Cole (1997) found that listening while reading as a preview resulted in greater increases in rates of accurate reading than did silent reading as a preview did. In a meta-analysis of repeated reading studies, Therrien

(2004) found that repeated reading improved reading fluency and comprehension in students regardless of disability status. Reutzel and Hollingsworth (1993) found increases in oral reading fluency and gains in comprehension scores using oral recitation lessons (ORL) in their study comparing ORL and group round robin reading. Neddenriep, Fritz and Carrier (2011) found an increase in fluency and comprehension when using a repeated practice with performance feedback and error correction as intervention.

Read Naturally is an intervention system that combines these three fluency-building strategies. Gibson, Cartledge, Keyes, and Yawn (2014) utilized Read Naturally's Software Edition (SE) for targeting oral reading fluency (ORF), generalization and comprehension (2014). All of the participants increased their ORF and word retell fluency (WRF); all participants also made significant gains in comprehension measures after their participation in the Read Naturally Software Edition (RNSE) intervention. Similarly, in a randomized control trial of RNSE, there were statistically significant differences observed between the control (no treatment group) and the Read Naturally SE group for measures of fluency and accuracy (Christ & Davie, 2009).

There is a wide range of reading interventions for school districts, schools, and teachers to choose from when looking to address reading skill gaps and deficits; however, laws and regulations of No Children Left Behind (NCLB, 2001) and the Individuals with Disabilities Improvement Act (IDEIA, 2004) and now Every Student Succeeds Act (ESSA, 2015) stress district and school accountability for the use of effective instructional practices and effective early intervention and prevention services.

Schools were faced with the challenge and immense pressure under NCLB to reach 100% proficient readers from both legislation and their individual districts; under

this pressure they were also left to independently select programs and interventions to assist their struggling students (Reed, 2013). The NCLB helped to expose achievement gaps and stimulated important dialogue around education improvement (U.S. Department of Education, n.d.). The accountability brought about by NCLB has been crucial in ensuring quality education for all children however, there were immense challenges in the implementation for meeting (U.S. Department of Education, n.d.).

It became evident that the NCLB requirements were increasingly unattainable; with this in mind and the call from educators and families, the Obama administration worked to create a better law with a focus on preparing all students for success in college and careers (U.S. Department of Education, n.d.). This came about with the reauthorization of the Elementary and Secondary Education Act under the new name, the Every Student Succeeds Act (U.S. Department of Education, n.d.). While there is more flexibility instead of one-size-fits all federal requirements for identification, interventions and accountability, there is still the expectation of success for students and schools through high academic standards, measuring student progress toward goals, utilizing evidence based interventions, and the expectation of accountability for all students and schools to improve.

Choosing a strategy can be difficult for teachers when trying to incorporate research findings into their classroom practice; this can be especially difficult today with the wide range of student abilities, skill levels and needs that can be found in the classroom (Hasbrouck et al., 1999). The NAEP data from 2015 demonstrated that 36% of fourth grade and 34% of eighth grade read students performed at or above proficient; meaning that 64% and 66% respectively, performed below proficient. While the push of

expectation for success and progress of all students already being challenging, it becomes more so when trying to intervene, particularly if there is a significant amount of the population who are not fluent by grade level. With new technology opening the gate for the development of even more interventions, the decision can become even more difficult.

Technological Delivery of Interventions

Inadequate financial and personnel resources can make it difficult to provide additional time and extra intensity of instruction necessary to help students with reading disabilities avoid falling behind in reading development (Fielding, Kerr & Rosier, 2007). Advances in computer, literacy, and communication technology have resulted in the development and exploration of new possibilities for educational programs, including instruction and intervention for reading and literacy skills. These developments have the potential to combat some of the problems that schools have to overcome in order to provide additional, intensive instruction to students who are struggling.

Computer technology has the capacity to provide highly specialized instruction and practice opportunities and can potentially be implemented with relatively low cost per seat with relatively high and consistent implementation integrity (Torgesen, Wagner, Rashotte, Herron & Lindamood, 2010). Not only can it provide highly specialized instruction, but it can also provide this instruction in an attractive way for students - with animations and immediate feedback (Fast, 2007). Moreno (2006) suggests that providing instruction in attractive ways that is also specialized and provides immediate feedback, scaffolds and supports memory and attention processes central to learning.

The use of technology for interventions has been explored for years; advancing development continually offers new possibilities. Computer assisted instruction (CAI) has been found to provide effective instruction for phonological awareness and word identification skills of 1st graders struggling to learn to read (Baker & Torgesen, 1995). As of 2007, What Works Clearinghouse reported significant effects on word level reading skills from five out of seven software programs that had been evaluated in high-quality experimental research. More recently, there was a large-scale evaluation of five computer-based reading programs used to provide instruction to 1st grade students in reading in 42 schools with 2,619 students; however, no significant gains to reading growth were found from the computer based instruction (Dynarski et al., 2007). Dynarski and colleagues (2007) reported evidence that in some of these instances, the computer programs were used to replace instruction instead of supplement it, which they were not intended to do.

Utilizing technology for instructional purposes has also been shown to increase student engagement. In one study that surveyed students, 66% of 116 students surveyed from grades 1, 4, 5 and 8 reported that they were more likely to engage in class if technology was used while 71% of teachers reported that they perceive students were more motivated and engaged when they utilized technology (Godzicki, Godzicki, Krofel & Michaels, 2013). Dynarski et al. (2007) found that young students had been observed to be more actively engaged in learning with using more technologically-based products, such as software when compared to more traditional instructional approaches. Studies suggest that computer-assisted instruction could be a promising intervention modality for young students, including those with attention problems and those who have identified

disabilities such as ADHD (Murray & Rabiner, 2014). Some advantages include the ability for the programs to adjust to students' specific instructional levels and provide immediate and specific feedback in order to maximize the rate of learning and instructional features such as animation that are engaging to young children; both of which are engaging and can improve learning (Murray & Rabiner, 2014).

Advances in computer, information and communication technology have launched new possibilities for reading and literacy interventions (Falth et al., 2013; Nicolson, Fawcett, & Nicolson, 2000). Some districts have the resources and ability to utilize technology such as computerized interventions for students (Reed, 2013; Torgesen et al., 2010). Torgesen and colleagues (2010) stated that these computerized interventions are used in many districts for at-risk students and that they can provide a highly-specialized instruction and practice for relatively low cost with relatively high and consistent fidelity. There is a need for more research that examines the conditions under which computers can be used effectively to help prevent reading difficulties in students at risk for reading difficulties based on the need for cost-effective intervention methods and current questions about the utility of computers to support effective early reading instruction (Torgesen et al., 2010).

Read Naturally

Read Naturally is an intervention system designed with the three research based strategies that include repeated reading, reading with a model, and progress monitoring with feedback in order to primarily target fluency and accuracy. To a lesser extent, the program also includes activities to improve vocabulary knowledge and reading for meaning (Christ & Davie, 2009; Read Naturally, 2009). Hasbrouck and colleagues (1999)

found evidence that elementary and middle school students using Read Naturally generally approximate typical or ambitious rates of achievement on ORF. Read Naturally is an intervention package often utilized by schools. They now offer their traditional package (led by teacher and/or audio CD), a CD software edition, and a web-based cloud product, "Read Live" (Read Naturally, n.d.).

As of July, 2013, The What Works Clearinghouse (WWC) identified 58 studies that investigated the effects of Read Naturally on the reading skills of beginning readers; of those, 11 were reviewed against group design evidence standards. Four studies were randomized controlled trials (RCTs) that met WWC evidence standards without reservations and one study was a quasi-experimental design that met WWC standards with reservations. Of these studies, Read Naturally and Read Naturally's CD software edition were both studied, but are not compared to each other. Read Live, Read Naturally's web-product has not yet been studied (What Works Clearinghouse, WWC, 2013).

With districts facing pressures to ensure that 100% of their students are proficient readers despite budgetary and legislative restraints, it is important that schools have information on the effectiveness of interventions (Reed, 2013). Since the Read Live web version of Read Naturally has not been studied in relation to the traditional Read Naturally, it is important to explore this relationship to see if there are differences due to delivery method so schools can make informed decisions.

The Present Study

Because technological interventions have the capability to provide highly specialized instruction and practice for large numbers of students (Reed, 2013; Torgesen

et al., 2010) and schools are challenged to reach high levels of proficiency and ensure student progress with increasing demands on finances and personal resources (Fielding, Kerr & Rosier, 2007), technological interventions may prove to be advantageous for schools and districts. When making the decision regarding what interventions to use, schools and districts should be aware of the research based evidence. Part of this is determining whether technological interventions are just as effective as more traditional interventions, if not more (Reed, 2013). While Dynarski et al. (2007) examined the use of software products in classrooms and not specifically interventions, they found that test scores in treatment classrooms that used computer software products (programs provided: instruction, tutorial modules, skills practice and tests) and those in control classrooms that used traditional teacher approaches, did not statistically differ. If computerized interventions are at least as effective as traditional methods, schools could consider utilizing these types of strategies for intervening with students efficiently and effectively. Educators could effectively intervene with larger groups of students with computerized interventions (Reed, 2013) which could free up personnel to work with other students who have different needs.

The main purpose of this study was to determine whether the delivery method of a multi-component reading fluency intervention (traditional vs. computer-led) makes a difference in helping to effectively increase ORF of third-grade participants over an 8-week period of intervention implementation. Hasbrouck and colleagues (1999) found evidence that elementary and middle school students using Read Naturally generally approximate typical or ambitious rates of achievement on ORF. While the Hasbrouck et al. (1999) study examined the traditional format, it was hypothesized that this would be

true for both the traditional and computer delivered models in this study. It was also expected that these rates will approximate expected rates of improvement within a typical population. However, since Torgesen, et al. (2010) discussed that computer facilitated interventions have the capacity to provide highly specialized instruction with consistent implementation, it was predicted that students in the computerized intervention group would display more improvement due to predicted greater adherence to the intervention steps. Expected rates of improvement were measured by slope of improvement based on weekly progress monitoring of ORF. Additionally, we tested whether there were differences between the two intervention groups for distal measures related to increased reading fluency through a post-test assessment of vocabulary knowledge and reading comprehension as improvements to reading fluency have been found to be positively correlated with improvements to reading comprehension, (Neddenriep, Fritz & Carrier, 2011; Pikulski & Chard, 2005; Rasinski, 2014).

This study also examined whether method of delivery of a reading intervention resulted in differences in student engagement. Godzicki and colleagues (2013) found that students reported to be more engaged and teachers perceived students to be more engaged and motivated in classrooms that utilized technology to support instruction. It was hypothesized that students assigned to the computerized intervention would express that they were more engaged than those students who were assigned to the traditional format. Engagement was measured using a survey created by the researcher and administered to all the participants at the conclusion of the intervention period.

Finally, the study examined whether differences were observed between the integrity with which each intervention was implemented. It was hypothesized that

implementation integrity would be facilitated by the computerized intervention method, because access to the intervention components is facilitated by the delivery method itself. Torgesen, et al. (2010) discussed that computer facilitated interventions have the capacity to provide highly specialized instruction with consistent implementation, thus it was predicted that higher implementation fidelity would be observed in computerized intervention method in the context of the present study.

CHAPTER 2

REVIEW OF THEORETICAL AND EMPIRICAL LITERATURE

Introduction

The modern scholarly examination of reading fluency as an important development in reading acquisition emerged from the postulates presented by LaBerge and Samuels in their 1974 publication (Pikulski & Chard, 2005). Pikulski and Chard (2005) summarized the historical development of the reading fluency construct, which asserts that human beings can attend to only one thing at a time; however, they can do more than one thing at a time if the activities can be completed through altering attention between them or if one of the activities is so well learned that it can be performed automatically. This hypothesis has been applied the construct of reading fluency to theories of developmental reading acquisition and reading comprehension through multiple theories and models that share similar concepts allowing for a consistency in argument for the importance of fluency (automaticity). LaBerge and Samuels (1974), Smith (1971, 1975, 1977), Gibson and Levin (1975), Samuels (1994), Sadoski, McTigue and Paivio (2012), Perfetti (1986), and Ehri (1996, 1998) have all develop theories or models that at least in part share this concept of fluency. This chapter will describe these various theories, how early reading instruction has been influenced by these theories and the interventions that have been developed to facilitate the acquisition of fluent reading.

Theories of Reading Fluency

Around the early to mid-1970s, several theories about reading acquisition emerged. Angus (1978) compared three models of the reading process proposed by Smith

(1971, 1975, & 1977), Gibson and Levin (1975), and LaBerge and Samuels (1974). The theories proposed by Gibson and Levin (1975) and Smith (1971, 1975, & 1977) shared similar views, asserting that featural information (the presence or absence of certain distinctive features such as curvature, angles, etc.) is sampled from the text, with only a few features from each word or word group being used to read the text. This follows an "economy principle" and involves the reader processing the least amount of information possible while making use of one's prior knowledge to reduce the amount of featural information that needs to be processed (Angus, 1978, Gibson & Levin, 1975, Smith, 1971, 1975 & 1977). For Smith (1971, 1975, & 1977), fluent reading involves immediate comprehension of the word meaning without taking steps of letter or word identification. Mediated reading (using the steps of letter and word identification) can only effectively be used if meaning is realized otherwise there is too much of a burden on memory and comprehension is lost. Gibson and Levin (1975) and LaBerge and Samuels (1974) proposed theories that placed less emphasis on meaning as a necessity for decoding, and proposed that beginning reading (mediated reading) and fluent reading are essentially the same process (involved the same step) with practice leading to fluent reading. Angus (1978) asserted that though it was not explicitly stated, this seemed to imply that all that was required for beginner readers to become fluent was more practice to develop it become automated. Smith (1971, 1975, and 1977) on the other hand, claimed that beginning and fluent reading were two different processes.

In Angus' (1978) comparison, he proposed that Smith (1971, 1975 & 1977) and LaBerge and Samuels (1974) had the most dissemblance while Gibson and Levin (1975) appeared to fall somewhere in between. He summarized that Smith (1971, 1975, & 1977)

and Gibson and Levin (1975) both purported that featural information was sampled rather than processed all together, that structural text information was combined with one's own prior knowledge to reduce the amount of decoding necessary, and that decoding to sound was not necessary for fluent reading. They also shared the idea that it was not useful to view reading as a set of separate skills to be taught separately (Angus, 1978). On the other hand, Gibson and Levin (1975) shared LaBerge and Samuels (1974) views that meaning is not necessary before decoding to sound is done, and that the transition from beginning reading to fluent reading is gradual and with practice, mediated skills become automated, resulting in fluent reading. Angus (1978) concluded that in the classroom, Smith (1971, 1975, & 1977) would place emphasis on the child reading meaningful text from the start; Gibson and Levin (1975) would share this, but with more structured exercises, and LaBerge and Samuels (1974) would focus on learning separate skills and gradually integrating them with practice to become automatic.

While all three models share similarities and divergences, the Gibson and Levin (1975) and Smith (1971, 1975, & 1977) theories formed the foundation of the top-down reading process theorists who went on to develop theories of reading development and instructional techniques that rely on meaning and comprehension processes for text reading competency. In contrast the LaBerge and Samuels (1974) became the theory from which most modern bottom-up theories of reading acquisition emerged. These bottom-up theories purport that efficient word-level reading process to enable higher order reading comprehension processes.

The LaBerge-Samuels (1974) model examined several components in the information processing systems involved in reading that included visual memory;

phonological memory; episodic memory and semantic memory. The LaBerge-Samuels model identified components in the information processing system and then hypothesized the route that information takes as it passes through this system. Their theory also identified changes in the form of the information as it moves from the surface of the page that one is reading, into the deeper, semantic-linguistic centers of the brain (1974; Samuels, 1994).

Attention is at the heart of the LaBerge-Samuels model; within this model, attention has two components: internal and external (LaBerge & Samuels, 1974; Samuels, 1994). External attention is defined as orienting behavior, which is typically what teachers and other educators perceive as a student's level of paying attention; it is a prerequisite for the reading process (Samuels, 1994). While external aspects of attention are a prerequisite, internal aspects of attention are even more crucial in the LaBerge-Samuels model (Samuels, 1994). The internal aspect of attention can be considered alertness, which is defined as an active attempt to encounter sources of information, having vigilance and level of selectivity in being unaware of other competing stimuli (Samuels, 1994).

Visual information from the text is processed in the visual memory component of the LaBerge-Samuels model; after this, auditory representations of the visual codes are processed in the phonological memory unit of the model (LaBerge & Samuels, 1974). They theorized that episodic memory records contextual details pertaining to time and place, and semantic memory serves as a storage unit for knowledge of all kinds. Attention is required to process all of this information (LaBerge & Samuels, 1974).

The visual memory unit of LaBerge and Samuels (1974) model is perhaps the most influential part of their theory in supporting the importance of word reading fluency. Visual memory is the first component of the processing stage in the model where detectors process text features such as lines, curves and angles (LaBerge & Samuels, 1974). Attention is essential in the early stages of learning a perceptual code such as letter formation; however, once well learned codes are activated by stimulation, direct attention to lines, curves etc., is not required for processing (LaBerge & Samuels, 1974). Input into the phonological memory system comes from a variety of sources including visual memory, episodic memory, feedback from semantic memory, and articulatory responses, as well as, from direct external acoustic stimulation (LaBerge & Samuels, 1974). Individual word meanings are produced in the semantic memory component, where comprehension of the written message can occur (LaBerge & Samuels, 1974).

After some time and development of other theories, Samuels (1994) revisited the LaBerge-Samuels (1974) model of reading process in an attempt to explain new ideas about automaticity. In its infancy, the LaBerge and Samuels (1974) model attracted interest as it used the concept of automaticity to explain why some readers (fluent ones) were able to decode and understand text easily while others (non-fluent) had great difficulty. The model later provided the theoretical basis for interventions, such as repeated reading interventions, and more recently provided a foundation for cognitive psychologists offering new explanations to describe what happens when one develops a skill to automaticity (Samuels, 1994). In Samuels' (1994) revision to the model, he made a distinction between accuracy and automaticity by describing how a student can be accurate without being automatic (1994). When at the accurate level of skill

development, attention is still required (Samuels, 1994). This addition to the theory provided insight into developing interventions that move students beyond accuracy and into automaticity.

Sadoski, McTigue and Paivio (2012) presented the Dual Coding Theory (DCT) of decoding that reinterprets the LaBerge and Samuels (1974) model. They claim that the LaBerge-Samuels (1974) model served well in accounting for decoding behaviors and the underlying processes; thus they include the LaBerge-Samuels model into the DCT and add an explanation of reading comprehension (Sadoski, McTigue, & Paivio, 2012). As previously discussed, the original LaBerge-Samuels model was considered bottom-up and did not describe mechanisms for higher order processes such as comprehension to affect lower order processes such as grapheme-phoneme correspondences (Sadoski, McTigue & Paivio, 2012). Samuels (1994) later revised the model by adding in feedback loops to make it more interactive by allowing for higher order processes to simultaneously influence lower order processes; though the emphasis still remained on decoding (Sadoski, McTigue and Paivio, 2012).

In the DCT model, feedback loops allow higher-order processing (comprehension) to influence lower order processing (visual or phonological processing) (Sadoski, McTigue & Paivio, 2012). Both the DCT model and the LaBerge and Samuels model start with external stimuli in the form of readers detecting written language, starting with features of print. Visual letter logogens (letters) can be activated holistically without active analysis of their features. Letters then activate associated phonological features and phonemes, depending on the context (i.e. determining whether a hard or soft c is activated by the print context). Letters then combine into visual spelling patterns,

which also can be recognized directly without analysis of individual letters if they pattern is learned. These patterns activate phonological associations. The next hierarchical process is word level recognition (visual word logoens). These can be perceived as a whole if well learned (i.e. sight words) or can be synthesized from the perceived spelling patterns. These words activate then pronunciations (Sadoski, McTigue & Paivio, 2012).

In the DCT model, words are associated with other words in meaningful ways, such as verbal associations (i.e. synonyms: integrity may be associated with honesty), or through concrete word images (i.e. phone may activate cell). These words can activate images (imagens) and can activate other modalities such as auditory images (i.e. the sound of a phone ringing). Word groups can be perceived as units as well, that can also evoke mental images. Feedback loops are present throughout these processes, with each being able to influence the other. In this model, comprehension processes are more explicitly used; for example, in the LaBerge and Samuels model, the term "meaning code" is used with little explanation. In the DCT model, meaning is explained in terms of the verbal and nonverbal codes that are modality specific (visual, verbal, etc.). Words can gain meaning from their association with other words (i.e. integrity and honesty). There is a network of associations available. With changing contexts, for example, with the evocation of mental images, meaning of a particular word can change (i.e. integrity of a bridge, may bring about visual images of a bridge, and verbal associations of strength and stability). In the DCT model, imagery is implicated in the construction of elaborate, novel, and imagined situations that go beyond what may be stored in episodic memories. The concreteness of words plays a direct role in reading comprehension due to the association with networks of language associations. Overall, with the LS model's

subsumption into the DCT model, there is an added description of comprehension. Sadoski, McTigue and Paivio (2012) argued that this constituted an advancement toward a more powerful and unified account of reading phenomena.

The idea that there are limited cognitive resources for information processing is a common theme across many theories of reading including Perfetti's Verbal Efficiency theory (Perfetti, 1986). Verbal efficiency theory suggests that individual differences in comprehension skill come from differences in lower level linguistic skills and abilities that manifest themselves in word identification and memory (Perfetti, 1986). This follows the idea that higher level comprehension processes depend upon, at least to some extent, resources of lower level processes such as word identification (Perfetti, 1986). Thus, comprehension processes can be compromised when lower level processes are using up a large amount of resources. Conversely, when word identification processes become automatic, resources are freed up for use by comprehension processes (Perfetti, 1986). Much like the LaBerge-Samuels model, the verbal efficiency theory focuses on attentional demands at different levels of processing, and that when lower level processes demand too much attention, higher processes suffer. This again, makes the case for developing automaticity in lower level cognitive processes, such as word reading skills, to free up attentional resources for higher order skills, such as comprehension.

Ehri (1995, 1998) also addressed fluency within her developmental reading acquisition theory. Ehri's theory (1995, 1998) is that readers systematically progress through stages to achieve fluency. There are four stages: the pre-alphabetic stage, the partial alphabetic stage, the fully alphabetic stage and the consolidated alphabetic stage (Ehri, 1995; Ehri, 1998; Ehri & McCormick, 1998). Readers start out with no

understanding of the alphabetic principle and progress through the stages until the final stage where readers can instantly recognize words, and are able to store word units and letter patterns through repeated encounters. Pikulski and Chard (2005) outline Ehri's nine-step instructional program for improving fluency, including: building graphophonic foundations for fluency; building and extending vocabulary and oral language skills; providing instruction and practice in recognition of high frequency vocabulary; teaching common word parts and spelling patterns; teaching, modeling and practicing decoding strategies; using appropriate texts to teach strategies and build speed; using repeated reading procedures as an intervention approach for struggling readers; extending growing fluency through wide independent reading; and monitoring fluency development. These elements of intervention are based in theory and used in the theoretical development of the Read Naturally intervention and procedures.

While there are many different models of reading development that discuss fluency, many trace their beginnings to LaBerge and Samuels (1974), and have the same underlying principles. Each theory or model may have a different term for various centers or processes in the brain but all at least in part make reference to the idea that automaticity is needed to have enough available resources to construct meaning from the text, rather than holding pieces of words or groups of words together to decode. Because of this, comparisons can be made between models and despite sometimes different terms or foci, the consistent argument for developing fluency or automaticity can be defined.

Applying Fluency to Early Reading Instruction

Fluency is one of the five components (phonological awareness, phonics instruction, fluency, vocabulary, and comprehension) of reading development that the

National Reading Panel determined to be most the critical objectives in early reading instruction (National Reading Panel, 2000). Students who have poor reading fluency read haltingly and slowly, often producing only a single word at a time; they also often ignore punctuation, so phrases and sentences become meaningless combinations of words rather than purposeful text (Hasbrouck et al., 1999). This can severely limit their overall understanding of text and passage meaning (Hasbrouck et al., 1999). Disfluent students also often read without any expression, which further contributes to limited comprehension. Consequently, many students with poor fluency lose interest in school activities, rarely read for pleasure, continue to fall behind in academics, and develop negative feelings of self-worth (Hasbrouck et al., 1999). Stanovich (1986) demonstrated a clear relationship between fluency and the amount of reading with which a reader engages, showing how readers grow in skills that contribute to fluency and in fluency itself while nonfluent readers who avoid reading fall further behind.

Another way to think about fluency is to conceptualize it as automaticity. Automaticity is defined at the ability to perform complex skills with minimal attention and conscious effort (Samuels & Flor, 1997). As described in automaticity theory, when reading subskills are performed automatically, higher order aspects such as comprehension and metacognitive functions can be performed effectively at the same time (Samuels & Flor, 1997). Samuels and Flor (1997) point out that often times, students only practice a skill until a high level of accuracy is reached; however, just because a student is accurate, does not necessarily mean they are automatic. Taking students beyond accuracy to the level of automaticity will likely result in a decrease in the amount of time spent in school spent re-learning previously covered material

(Samuels & Flor, 1997). This is because there is evidence that skills and knowledge learned to automaticity are better retained in long term memory; whereas, skills and knowledge only developed to accuracy - even if a high accuracy amount - will survive only for a short time (Samuels & Flor, 1997).

Samuels and Flor (1997) suggested that a second implication from automaticity theory comes directly from the reduced attentional demands needed to perform at that level: when a previously demanding task becomes routinized to the point where it requires significantly less cognitive attention, there exists a reserve of attentional energy available for expenditure on other tasks. This implication stems from the original LaBerge and Samuels (1974) theory. For example, the letter is the unit of word recognition for beginner readers, followed by the word for the skilled reader and holding meaningless letters in memory is more difficult than holding meaningful words (Samuels & Flor, 1997).

Notions of the reading process have led researchers to the idea that students can construct meaning as they read; as a consequence, it has been hypothesized that improving fluency may be related to the improvement of comprehension as well (Reutzel & Hollingsworth, 1993). Fast, accurate reading is a prerequisite for reading comprehension. When reading is not effortless enough, the ability to make and sustain meaning from what one reads is impaired, thereby explaining why tests of reading fluency demonstrate strong correlations with tests of comprehension (Biancarosa & Cummings, 2015). If text is read laboriously and inefficiently, as students with poor reading fluency do, it will be difficult to remember and relate ideas to past knowledge (National Reading Panel, 2000).

Pikulski and Chard (2005) point out that a very strong theoretical and research base indicates that while fluency itself is not enough to ensure high levels of reading achievement, fluency is absolutely necessary for that achievement because it depends on and reflects comprehension. With nonfluent readers, the process of decoding words drains attention and not enough attention is free for constructing comprehension (Pikulski & Chard, 2005).

How to Improve Fluency

Given the importance of fluency, it is essential to have effective interventions to target fluency. There are a wide range of interventions and strategies used to target reading fluency deficits and concerns. Some of the main strategies used are repeated readings, listening while reading, and assisted reading. Read Naturally uses all of these components within its procedures when followed with fidelity.

Repeated Readings

Pikulski and Chard (2005) stated that research demonstrates procedures based on repeated readings can help readers to improve their fluency. Repeated reading is an evidence based strategy designed to increase reading fluency and comprehension (Therrien, 2004). Therrian (2004) conducted a meta-analysis to try and define the essential instructional components of repeated reading and the overall effects of repeated reading on both fluency and comprehension. The findings from the analysis indicate that repeated reading improves reading fluency and comprehension of both students with and without learning disabilities; all students demonstrated a moderate mean increase in fluency and a somewhat smaller mean increase in comprehension (Therrien, 2004).

Findings were further broken down into non-transfer (reading the same practice passage) and transfer (reading on a new passage). There was a large effect size of 0.83 (0.066 SE) for an increase in non-transfer fluency with a moderate effect size for comprehension (0.67, 0.080 SE) (Therrien, 2004). Transfer results (the student's ability to fluently read or comprehend new passages after having previously reread other practiced material) indicate that repeated reading may also improve students' ability to fluently read and comprehend new passages (Therrien, 2004). Results demonstrated a moderate mean fluency effect size increase (0.50, 0.058 SE) and a smaller but still significant mean comprehension effect size increase (0.24, 0.067 SE). Overall, the analysis demonstrated that repeated reading has the potential to improve students' overall reading fluency and comprehension abilities in regard to new material (Therrien, 2004).

Therrien's (2004) meta-analysis also determined important components of repeated reading. Regardless of purpose, all repeated reading interventions should ensure that students read passages aloud to adults as fluency and comprehension effect sizes for students in transfer interventions that were conducted by adults were more than three times larger than those obtained by students in interventions conducted by peers (Therrien, 2004). Therrien also suggested that if the purpose of a repeated reading intervention is to improve a student's ability to fluently read and comprehend a particular passage (focusing on one passage rather than transfer skills), then the student should be provided with prompts to focus on both speed and comprehension and the passage should be read 3 to 4 times (2004). If the intervention purpose is to improve overall reading fluency and comprehension, a corrective feedback component should be added and passages should be read until a performance criterion is reached; all students involved in

adult run interventions that were given corrective feedback obtained a large mean fluency effect size increase of 1.37 (Therrien, 2004). Those that used a performance criterion obtained a mean fluency effect size increase of 1.70 which was more than four times larger than interventions that used a fixed number of re-reads (0.38) (Therrien, 2004). The Read Naturally programming uses a performance criterion for normal procedures (if followed with fidelity). Overall, Therrien's (2004) concluded that if repeated reading is intended as an intervention to improve student's overall fluency and comprehension, then it should include passages read aloud to an adult, corrective feedback on word errors, and use of performance criterion. Each of these conclusions correspond with the components of Read Naturally's reading intervention protocol.

Herman (1985) used a within-subjects single subject design to determine if the method of repeated readings could be used with non-fluent, less able readers to improve fluency. For three months, 8 non-fluent students from intermediate grades chose five separate stories to practice repeatedly following the Dahl (1974) and Samuels (1979) procedures. Results indicated that reading rate and scores for comprehension increased significantly and the total number of miscues decreased significantly not only within practiced passages but also between passages (Herman, 1985). Herman (1985) observed a continual rate of improvement in reading accompanied by a decrease in total number of miscues, and an increase in accuracy, and concluded that non-fluent, less able readers benefited from repeated readings.

Ardoin, Eckert and Cole (2008) evaluated the effects of two fluency-based reading interventions on student's immediate and generalized oral reading fluency rate. They used a within-subjects group design with a total of 42 second and fourth grade

students who were administered both Repeated Readings and Multiple Exemplars interventions. They then assessed the students responding to passages that contained high word and medium word overlap. Ardoin and colleagues (2008) found that student's fluency on intervention passages was significantly greater during the Repeated Readings intervention. On generalization passages that contained medium word overlap however, ORF was significantly greater following the Multiple Exemplars intervention. Multiple Exemplars is a variation of Repeated Readings were students practice reading the same words in multiple contexts as opposed to reading the same words in the same context. They hypothesized that this was due to the Multiple Exemplar medium word overlap passage being easier for students to read. Ardoin and colleagues (2008) found that the Repeated Reading intervention significantly improved student's oral reading fluency on intervention passages in comparison to the Multiple Exemplars intervention in which oral reading fluency rates remained stable. Generalized effects of the Repeated Readings intervention were less robust when students were provided with reading generalization passages; and the researchers suggested that Repeated Readings that required students to read different passages such as Multiple Exemplars may increase generalized responding (2008).

Klubnik and Ardoin (2010) used an alternating treatments design to compare the effects of two versions of a repeated readings intervention packed on generalization and maintenance reading rates for six 2nd grade students. Both intervention packages included a preview of listening to the passage, repeated readings, error correction and a contingent reward; the packages only differed in whether components were provided to students individually or in groups of three. In individual intervention, repeated readings were

completed individual. When in intervention in small groups, sequential reading was used where students read one sentence at a time, taking turns until the passage was completed. For 4 of the 6 students, intervention clearly resulted in greater increased in words read correct per minute and percentage of words read correctly than control on generalization passages at both post-intervention and maintenance measures. For 3 of the 4 students who benefited from the intervention, individual and small group interventions resulted in comparable gains; though, they did find that some students still had greater benefit from individual intervention. Finally, Klubnik and Ardoin (2010) found that each student's gains were not only maintained over time, but increased.

Ardoin, Morena, Binder, and Foster (2013) extended on repeated readings research by exploring the influence of prosody in repeated readings interventions. Thirty-eight 3rd grade students and thirty-eight 4th grade students were randomly assigned to either repeated reading and prosody condition or repeated reading with rate feedback condition. All intervention components were administered during one session lasting approximately 15 minutes. Students were instructed to do their best reading and then read from a CBM ORF probe. Students in the repeated reading and prosody condition were given feedback regarding their prosody and provided with error correction procedures (examiner reading a missed word, student repeating the word, and student re-reading the phrase containing the word). Students were then provided a 6-minute lesson on prosody, and given another CBM ORF. Students in the repeated reading and rate condition were given feedback on how much time it had taken them to read the passage follow by the same error correction procedures, played a 6-minute game, and then were cued to try to beat their previous times and then given another CBM ORF. This was procedure was

followed for four trials. The purpose of this study was to measure the impact of repeated reading on reading prosody of older students and to evaluate the extent to which instructions and performance feedback may influence students' fluency. Results varied based on condition, with performance generally improved on prosodic measures for students in the prosody condition, and rate improving for those in the rate condition. Overall, Ardoin et al. (2013) found results that supported research suggested that repeated reading improves students' reading fluency. Results also showed support for the importance of messages conveyed to students in feedback, as the component of reading fluency that was improved during intervention varied as a function of the directions and feedback provided to students (Ardoin et al., 2013). Research suggests that repeated reading is an evidence based practice that can improve students' reading fluency (Ardoin et al., 2013; Herman, 1985; Therrien, 2004).

Assisted Reading

Assisted reading is when a student reads a text while simultaneously listening to a fluent oral rendering of the text (whether it be an adult, teacher, or recording) (Rasinski, 2014). This practice allows students to decode all the words in a text successfully, even those that they would not necessarily be able to decode if reading on their own. It also provides the student with a positive model of an expressive and meaningful reading of the text (Rasinski, 2014). Rasinski (2014) adds that wide reading, repeated practice of the same text (repeated reading) and rehearsal (reading scripts, poetry, songs, speeches, etc.), are opportunities to help developing readers read independently in order to achieve high levels of fluency, automaticity and prosody in their own reading.

In a review of the literature, many studies involved both assisted reading and listening while reading as there is a small distinction in that in assisted reading students read along aloud with the model while in listening while reading it can be read aloud or silently. For example, Esteves and Whitten (2011) compared the use of digital audiobooks for assisted reading to sustained silent reading. This study could be considered listening while reading however, as students could read silently. Twenty students identified with documented reading disabilities were assigned to either participate in sustained silent reading or utilize assisted reading procedures for 20 to 30 minutes a day for four to five days a week for eight weeks. The students in the experimental condition listened to digital audiobooks on their MP3 players while reading along with the text. Results showed that upper elementary students identified as either having a learning disability and/or ADHD demonstrated a greater increase in reading fluency rates, as measured with DIBELS ORF probes when assisted with reading with digital audiobooks was utilized as compared to the control group that participated in SSR (Esteves & Whitten, 2011).

One of the original studies involving assisted reading was conducted by Chomsky (1976) when a teacher asked for assistance with several struggling readers. Chomsky assigned five 3rd grade students who were reading below grade level to read along with books on tape. The students listened to their books every day, and followed along as they listened. They were instructed to listen to the whole book at least once, and repeat any part they wanted to prepare. The students were then to record themselves either reading along with the master tape, or reading independently. The research team listened to the recordings each week. Though there were no quantitative data reported regarding

improvement, both teacher and parent reports suggested an improvement in the students' reading over time and an increase in interest. While this intervention involved assisted reading when students recording themselves reading along with the tape, it was not required and thus could also be considered listening while reading.

Gilbert, Williams and McLaughlin (1996) studied the effects of assisted reading on 3 elementary students with learning disabilities using a multiple baseline design. During baseline procedures, students participated in a teacher's introduction and discussion of vocabulary from the stories with students and teaching of phonetic rules and generalizations followed by silent reading practice of a passage and reading into a recorder with no feedback. During assisted reading intervention, the teacher provided students with prerecorded passages of the stories, students listened to them while following the print, and then read the passage three times with the recording. After that, students read the story independently into a recorder. Gilbert and colleagues (1996) reported an immediate increase in correct reading rates for all three students with the implementation of assisted reading; one student increased from a mean of 28 words per minute in baseline to 60 in intervention, another from 58 words per minute to 83.5 and the third from 38 words per minute to 68. This study's procedure involved both assisted reading and listening while reading.

Listening while Reading

Another reading fluency intervention component is listening while reading (listening to a fluent model). The listening while reading intervention requires a student to read a passage (either aloud or silently) while the text is read aloud by a fluent model (Hawkins et al., 2015). When children observe fluent reading by adults and other fluent

readers, children can increase their motivation for reading, increase their vocabulary, improve their comprehension and be provided with a model of what oral reading should sound like (Rasinski, 2014). Research indicates that listening while reading may be applied to improve oral reading fluency (Hawkins et al., 2015). Hawkins et al. (2015) conducted a single subject alternating treatments design with four students to compare a listening while reading intervention and an adult-mediated repeated reading intervention. Both conditions had similar effects on reading fluency for 3 out of 4 participants, and the repeated reading was more effective for one. When accounting for instructional time however, listening while reading intervention was more efficient at improving fluency for ¾ students (Hawkins et al., 2015). This pattern was the same for comprehension data. For participants in this study, both components were important and effective in increasing students' fluency. Both of these components are significant parts of the Read Naturally intervention.

Computer Aided Learning

One way that interventions can be delivered is through the use of advanced technological tools such as computers. Technology has been used in both instruction and intervention in schools since the 1900s with great advances in computer technology having been made since the 1980s resulting in even more technological tools for schools (Reed, 2013).

The idea that computer aided learning (CAL) programs could potentially provide for educationally efficient and cost effective methods in education has been appreciated since the 1960s (Nicolson et al., 2000). These programs can provide immediate feedback, go at the individual student's pace, are non-judgmental, are often predictable, can provide

essential over learning, can store and access information about the student, and can provide new motivation (Nicolson et al., 2000). However, Nicolson and colleagues (2000) suggested that traditional computer programs were not accessible for children who had learning disabilities as it was hard to program speech, it was impossible to program multisensory output, and there was limited adaptability to error. They also relied on written instructions and lacked human contact, which can be difficult for students with disabilities or weaknesses in these areas to access. Since then, Nicolson and colleagues noted that technology had progressed substantially by 2000, with multimedia environments, integration of text, graphics and synthesized speech, and click and point capability rather than use of keyboards, all of which have provided solutions to the inaccessibility of the first round of computer programs and older technology (2000). Advancements lead to promising benefits of using technology for intervening, including learning efficiency and cost gains associated with using paperless systems; particular benefits for use in special education; and greater learning personalization (Falloon, 2014).

Murray and Rabiner (2014) found that CAL appears to be a promising intervention for students who have attention problems or who have identified disabilities, such as ADHD, through increasing the amount of instructional time provided to at risk students in early elementary school (Murray & Rabiner, 2014). The ability for CAL interventions to provide immediate and specific feedback, provide engaging instructional features such as animation and interactive components, and the fact that it can actually be less costly than the time required for certified teachers to provide small group instruction are all promising benefits for use in intervening with students at risk (Murray & Rabiner, 2014).

Falth et al. (2013) designed a study to examine the effects of three computerized interventions on the reading skills of children with reading disabilities in second grade. The authors noted that advanced in information and communication technology have introduced new possibilities for remediation of literacy difficulties. When compared with traditional textbooks, or paperback books, computers can provide text and training material in an attractive way (Falth et al., 2013). These attractive ways include animations and immediate feedback (Fast, 2007). Providing training in these ways help to scaffold and support memory and attentional processes that are central to learning (Moreno, 2006). Falth et al. (2013) point out that strategies focusing on word exploration in a playful way by combining motivating computer programs with structure teacher and student interaction can not only promote reading and phonological development but also motivation and communication. They also noted that computer based training has been shown to be useful for students with reading difficulties (Falth et al., 2013).

In order to understand how technological intervention can be effective, the theoretical basis for this type of learning is reviewed. Moreno (2006) outlined the cognitive theory of learning with media. In this theory, instructional media that are entering the learner's auditory or visual sensory memory can be explained depending on how they are presented. Media may also include nonverbal information such as tactile, acoustic, visual or other sensory knowledge representations. All these different stimuli enter the corresponding sensory channel and then learners must attend to multiple information sources within a working memory of limited capacity and duration. Learners will only select a few pieces of information at any one time for processing. They will be forced to make decisions about how to connect chosen pieces and how to integrate this

information with prior knowledge. After it is integrated into long term memory, it can be retrieved and used as a schema within the working memory to further learning. Eventually, the new schema is retrieved automatically, requiring minimal working memory resources. Again with this theory, there is a focus on mental resources and the acknowledgement that automaticity reduces the attentional demands of particular processes so resources can be devoted to other areas for processing.

For cognitive psychologists, media refers to the physical systems or vehicles used to deliver the information (i.e. face-to-face instruction, textbooks, computers etc.) while method refers to techniques embedded in different media to promote learning (i.e. discovery methods, explicit instruction, and multimedia etc.) (Moreno, 2006). Thus, when thinking about the purpose of this study, both Read Naturally (RN) programs use the same methods, but different media (paper and pencil vs. computer). When thinking about technology, Moreno points out that with regard to the cognitive theory of learning with media (CTLM), a common pitfall of higher technology (new technology such as programs that use animated, life-like characters to facilitate learning in computers and virtual reality environments) is when it presents extraneous materials in a lesson or designs learning environments to force students to engage in extraneous cognitive processing which further limits cognitive resources available. Another problem commonly committed by higher technology educational tools is when there is a failure to include methods that promote the learner to actively process materials. Finally, it is important that opportunities are given for obtaining feedback and reflecting on the activity, otherwise learning may not occur. Based on this Moreno (2006) determined that instructional technologies can promote meaningful learning when essential verbal and

nonverbal materials are included, and when learners are allowed to interact or reflect about the materials with the help of structured guidance. These principles can be found in Read Naturally's Software Edition (RNSE)'s procedure through the interaction with the program, cold and hot timings, and monitoring of student progress that the student is also able to see live with graphs and feedback.

Studies Involving Computer-Facilitated Interventions

Based on the potential advantages of using computers for intervening with students, many studies have been done to examine whether these advantages exist. These studies have been done as more and more technological developments have been made. A few of these studies are reviewed to examine the types of research that have been done regarding computer interventions to date.

Baker and Torgesen (1995) evaluated the use of computer assisted instruction (CAI) to train phonological awareness skills in first graders at risk for reading failure. Fifty-four students were divided into three experimental conditions (group 1: 25 minutes per day, four days per week with two phonological training programs; group 2: same amount of time with program designed to train alphabetic decoding skills; group 3: attentional control group that spent equal time on the computer with several programs designed to provide basic math skill practice). The children exposed to the phonological awareness training programs made significantly greater improvements on several measures of phonological awareness and on a measure of word recognition, when compared to children in the other two groups. Baker and Torgesen (1995) argue that if computers can be used to provide effective instruction in the area of phonological awareness, this would be one way to ensure that children receive high quality, consistent

instruction in this area. Baker and Torgesen (1995) do not suggest that CAI has unique advantages over teacher lead instruction in enhancing this skill, but are rather concerned with the practical issue of whether effective instruction can be provided within the limitations of computer technology.

The results from Baker and Trogesen's (1995) study demonstrated that training provided by the two programs (Daisy Quest and Daisy's Castle) significantly increased the children's ability to perform both computer presented phonological awareness tasks and orally presented tasks of phoneme analysis, suggesting these findings imply that computers can clearly provide effective instruction in phonological awareness. One of the benefits in particular of these programs that Baker and Torgesen (1995) found to be effective was that students had the opportunity to hear the word as many times as they needed by simply moving the cursor over them. This review capability is built into the Read Naturally program; students can review words that are unknown to them by moving the cursor over them.

In another study to test the effects of CAL(I), Falth et al. (2013) divided 130, second grade students into 5 groups (group 1: aimed at improving word decoding skills and phonological abilities; group 2: word and sentence levels; group 3: combination of training programs from group 1 and group 2; group 4: ordinary special instruction; group 5: comparison group). The programs aimed at improving word decoding skills, phonological abilities and word and sentence levels were all computerized. The Omega-Interactive Sentences program was used for the intervention aimed at improving comprehension at the word and sentence level processing and involved immediate feedback with speech and animations for both words and sentences. Computerized

Phonological Training (COMPHOT) was used for the intervention aimed at improving decoding and phonological abilities; it involved decoding, rhyme, and segmentation exercises. Thus, groups 1, 2, and 3 all received computerized interventions. Those in the ordinary special instruction group completed activities related to reading and writing including reading aloud or silently, discussing stories, instruction in spelling rules and phonological awareness, with occasional memory training; special education teachers could structure them depending on the participant (Falth et al., 2013). The comparison group consisted of typical readers who did not receive specialized instruction. All groups were found to have improved their reading skills; however, the combined training group showed greater improvement that the one with ordinary special education and the group of typical readers at two follow ups (Falth et al., 2013). The majority of students from the combined group were judged to no longer need special education 1 year after intervention (Falth et al., 2013). Falth et al. (2013) state that the results demonstrated that gains in decoding, reading comprehension and nonword reading can be achieved by intensive computerized phonological training in combination with computerized reading comprehension training and that these gains persist over a 1 year follow up period post intervention. This study took place in Sweden, where it is common for special education and classroom teachers to together decide whether a student may receive special education after the identification of the student's strengths and weaknesses (Falth et al., 2013). Only 7 out of the 25 in the combination group needed special education at the 1 year follow up while 20 out of 25 and 22 out of 25 in the other groups did (Falth et al., 2013).

Christ and Davie (2009) evaluated the effect of the Read Naturally Software Edition (RNSE) intervention (a computer intervention) on skill development. A randomized controlled trial (RCT) was conducted across six schools in four districts with 109 low performing third graders where intervention was provided for 20 minutes per day for 10 weeks (Christ & Davie, 2009). Students in the RNSE condition outperformed students within the control conditions on all measures of accuracy and fluency, although not all differences were statistically significant. Statistically significant differences were observed between the control (no treatment) and experimental conditions for both accuracy and fluency measures. While there was not a statistically significant effect for comprehension measures, this was expected as the procedures and instructional targets focus primarily on accuracy and fluency skills; researchers would expect comprehension gains over more extended periods of implementation and not necessarily over only 10 weeks of implementation (Christ & Davie, 2009).

The researchers noted that observed gains for the experimental group were obtained with minimal resources which is beneficial as teacher and personnel time is one of the most valuable resources in schools. They also note that these results were observed within conditions where there was minimal training and teacher support for implementation, which are often conditions teachers face when implementing various programs (Christ & Davie, 2009). Other benefits include that the intervention can be scaled and the results support the conclusion that the intervention is both effective (to accelerate accuracy and fluency gains) and feasible (Christ & Davie, 2009).

Gibson, Cartledge, Keyes and Yawn (2014) also examined the RNSE computer based intervention. Gibson and colleges (2014) designed a study to investigate the effects

of RNSE on the ORF and comprehension on generalization passages for 8, 1st grade students with reading risk. They used a multiple probe experimental design with two treatment phases (Gibson et al., 2014). Results showed that ORF and comprehension increased in both phases; however, satisfactory generalization did not occur for most of the participants until the second phase was implemented (Gibson et al., 2014). Gibson and colleagues (2014) noted that an important issue and potential problem with the use of supplemental interventions is the time and resources needed to implement them properly and that this is especially true of supplemental instructional strategies that use multi-component interventions where schools may lack the personnel and time needed for small group/individualized instruction. One option they recommend is to deliver the intervention through computer software, allowing more for independent student delivery rather than relying solely on the teacher (Gibson et al., 2014). The purpose of their study was to implement a computer program explicitly as supplementary instruction in order to determine its effectiveness.

An important part of the Gibson and colleague study (2014) was a social validity component in which questionnaires were used to gain insight into how teachers and students felt about the use of RNSE. All teachers responded that they believe their students enjoyed the program and would allow their students to participate in similar instructional interventions in the future; all students indicated that they enjoyed the program and believe that they had become stronger readers (Gibson et al., 2014). The students also indicated that they wanted to continue to use the program in the future (Gibson et al., 2014).

While all students increased their Oral Reading Fluency (ORF) and Word Reading Fluency (WRF) on both training and generalization passages, for some participants the increase was slight and for others it was substantial. There were also only marginal gains in generalization to untrained passages, which is consistent with other studies in this area. An important outcome of this study was more information to bridge the gap between the need for effective supplemental instruction and the resource realities of the classroom; once students learned the program, the demands on the experimenter were minimal (Gibson et al., 2014). The only time adult supervision was required was at the beginning of the program for training and to listen to the pass timings for each treatment story. The authors state that this study's outcomes underscore the potential for computer based programs to serve as delivery mechanisms for efficient and effective supplemental instruction for students at risk for academic failure, who would otherwise go lacking (Gibson et al., 2014).

Motivation and Increased Engagement

Beyond improvements in achievement, others claimed benefits of using computers and tablet based technologies in education include enhanced motivation and engagement, which are likely to lead to improved learning (Falloon, 2014). These enhanced motivations resulting in more active engagement plays a role in student effort and achievement.

Malone (1981) argued that one of the principal rationales of using computer technology in learning is that it can motivate students who are not motivated by more traditional methods. Nicolson and colleagues (2000) used an informal teacher rating in their study and found that groups using the computerized Reading Interactive Teaching

Assistant (RITA) intervention appeared to be more enthusiastic and eager to leave the regular classroom lesson and more to their small reading group work than those not using the CAL program. The RITA intervention was a computer program designed for Macintosh computers that required the teachers to choose from a list of activities (i.e. Rhymes, Word Attack, Vocabulary, Word Flash, etc.) and resulted in a thirty-minute computer program individualized for the student.

Nicolson and colleagues (2000) designed a study to evaluate whether the use of computer aided learning techniques would be able to address the problem of children who did not benefit from traditional reading interventions methods. The computer based program used was RITA, a computer based literacy support system. Students in the RITA group made significantly more progress than control groups, though results varied slightly for the younger group (6 year olds) and the older group (8 year olds) with traditional intervention having a slightly higher effect size for the 6 year olds and low effect size for the older students. The RITA program provided satisfactory cost effectiveness at both levels, and was notably more cost effective than traditional support at the higher school level (8 year olds) (though there were a small number of children involved so this should be taken into consideration when interpreting the cost-effective results). The most notable finding of the study was that Nicolson, Fawcett and Nicolson (2000) found that children participating in the computer based presentation showed significantly higher levels of enthusiasm and commitment than with the traditional approach.

Godzicki and colleagues (2013) conducted an action research project in order to increase motivation and engagement in elementary and middle school students through

using technology supported learning environments. Participants included 116 students in 1st, 4th, 5th and 8th grade classes. Student and teacher surveys were used to define the problem of lack of student motivation. Researchers noted students were more likely to engage in classroom activities when technology was used; however, 47% of teachers responded that their students used technology for less than 80 minutes per day. To try to address the lack of student motivation, teacher researchers implemented a technology supported learning environment included technology supported lesson plans that featured computers, laptops, iPods, iPads, interactive whiteboards, student response systems, projectors, document cameras, video and audio recording devices, and computer software (Godzicki et al., 2013). After implementing the use of these designed lessons and environments, another survey was given in which students noted that they felt teachers provided activities related to their interests and that students were more likely to engage in classroom activities when technology was used. Teacher researchers concluded students were more motivated and engaged in learning when using technology. Overall, students' behavior was more animated towards the learning objectives when technology was utilized, as measured through surveys given to the teachers and students regarding student engagement and motivation. Students noted that they preferred technological tools, computers and laptops.

Bangert-Drowns and Pyke (2002) note that students are often enthusiastic and persistent in their interactions with educational software; however, this enthusiasm does not always translate into meaningful learning, which depends on the actual program and the interaction with the student's strengths, weaknesses and needs. With the right program, interaction with student needs, and support, it is suggestive that computer

programs may increase motivation and student engagement, that further aid in student development and achievement.

Challenges

Despite the potential benefits of using computer technology in instruction and intervention, limitations have been identified. Many of these limitations are linked to support and were found during various studies examining the effectiveness of such interventions. Much of these concerns are related to teacher training and implementation.

Murray and Rabiner (2014) stated that while CAI is a promising intervention for young, inattentive students, there are several implementation challenges. Based on this, they reviewed a recent RCT study of a CAI intervention, highlighted challenges to implementation, and suggested strategies for overcoming them in their 2014 article. For example, Murray and Rabiner noted that one area in particular, despite positive effects found when using CAI for young students who have attention problems and for those who are at risk for reading failure, is teacher preparation and praxis appears to be limited to support these practices (2014).

Despite the benefits, teachers themselves have reported some challenges with implementation. Murray and Rabiner (2014) reported that selection of a specific software product should be informed by existing research; however, identifying specific evidence based programs and matching them to student needs may be challenging for educators given the large variety and range of programs commercially available. There are also an increasing number of studies that may appear to have conflicting results or are difficult for educators to interpret (Murray & Rabiner, 2014). Unfortunately, teacher preparation and training in the area of use of computer assisted instruction and computerized

interventions appear limited which adds into implementation challenges (Murray & Rabiner, 2014).

While keeping in mind the potential limitations and challenges of using computer technology, research still suggests that computer technology can provide increases in student skills, achievement, motivation and engagement. In order for these benefits to be seen, the right computer programs need to be utilized, and these programs much have research based methodology and be followed to fidelity. One popular, well-researched reading intervention program is Read Naturally.

Read Naturally Research

Read Naturally is an intervention system designed with the three research based strategies of repeated reading, reading with a model and progress monitoring with feedback at its core in order to primarily target fluency and accuracy; it also includes skills of vocabulary and reading for meaning to a lesser extent (Christ & Davie, 2009; Read Naturally, 2009). Read Naturally comes in multiple media forms: their traditional package (led by teacher and/or audio CD), a CD software edition, and a web-based cloud product, “Read Live” (Read Naturally, n.d.).

Read Naturally research ranges from program evaluations to RCTS completed within schools. Hasbrouck and colleagues (1999) evaluated Read Naturally studies and found that it can effectively been used with Title 1, remedial reading, elementary, special education, and middle school students. Beyond improvement in reading, Read Naturally has shown an increase in self-esteem and confidence regarding academic capabilities and hope for future success in reading. Another important finding is the benefits from independent structure: the teacher can use his or her time to work among a larger group

of students, students reading at different levels can easily work alongside each other, and students feel that the progress they are making is coming from their own efforts (Hasbrouck et al., 1999).

Hasbrouck and colleagues (1999) published a seminal Read Naturally Study, that reported the results of an intervention that combined teacher modeling, repeated reading, and progress monitoring into the Read Naturally strategy in a third-grade classroom. The classroom included a mixture of special education students and Title I students. Special Education students were given Read Naturally and at the end of 7 weeks they had improved their fluency by an average of 2.35 words per week. Title I students, who did not receive Read Naturally, improved by 1.23 words per week. After the initial 7 weeks, Title I students were then given Read Naturally over 13 weeks; over this time, they gained an average of 2.15 words per week.

Another Read Naturally study involved a program evaluation of the most frequently used supplemental reading programs in Minneapolis Public Schools, completed by Heistad (2005). Four schools within Minneapolis Public Schools volunteered to participate in the evaluation of Read Naturally; two of the schools used the traditional format (Master's Edition) and two of the schools used the software edition. There were a total of 96 students using RN with 78 having pretest and posttest information available for analysis. Reading achievement was assessed using 3 types of reading assessment: the Northwest Achievement Levels tests (NALT) (administered to all students in the district), the Minnesota Comprehensive Assessments (MCA), and the Reading Fluency Monitor (developed by Read Naturally). The Reading Fluency Monitor is a curriculum based measurement reading assessment developed by Read Naturally

with the average number of words being read correctly used instead of the median (Heistad, 2005).

In this evaluation, each student receiving RN services was matched with a student not receiving RN services (matched on NALT pretest, grade, ELL status, SPED status, free/reduced lunch, ethnicity, home language, and sex). 93% of pairs were perfect matches. Reading Fluency Monitor data were analyzed using an independent t-test for differences in learning slopes versus the use norm group, with results showing that growth in fluency was equal or greater than the analysis of growth norms collected from sites that were using RN in classrooms in eight different states. RN students made an average of 2.5 scale score points greater on the NALT than students matched. Fluency gains in two high implementation sites were greater than typical annual fluency increases found in the RN norm group. ORF increases were also correlated with increased vocabulary and comprehension (as measured by NALT and MCA). Despite this being a small-scale study, it was an evaluation of students using RN for a year which resulted in increased reading test scores, significantly more than control students matched by initial test scores and student demographic characteristics (Heistad, 2005).

Christ and Davie (2009) evaluated the effect of the Read Naturally Software Edition intervention on skill development over a 10-week implementation period. The Read Naturally Software Edition (RNSE) uses the same model as the traditional format but requires a CD and computer to operate. Christ and Davie noted that to date in 2009, no RCTs of the RN program had been conducted. For their study, they designed a RCT to evaluate RNSE for use in remediating and preventing reading difficulties when used in

particular as a tier 2 supplemental application (though they noted that RN can be utilized at any tier) (2009).

Christ and Davie (2009) conducted a RCT across six schools in four districts with 109 low performing third graders. Students received the intervention for 20 minutes a day for 10 weeks. Results provided evidence of statistically significant differences and small to moderate effects on multiple standardized measures of reading accuracy and fluency (Christ & Davie, 2009). In this study, the purpose was to evaluate Read Naturally Software Edition for use in remediation and preventing reading difficulties with use as a Tier 2 application within a Response to Intervention model. Teachers reported that they found the intervention to have clear procedures, which were feasible for implementation within schools; they also reported it was acceptable however there was a perception that some system level support would be needed for implementation such as additional staff and or administration support. Statistically significant differences were observed between the control group who had no treatment and the experiment (Read Naturally) condition for both accuracy and fluency measures. There was not a statistically significant effect for comprehension measures; however, it would be expected that comprehension improvement would be seen over time, not necessarily only after 10 weeks of implementation.

Perhaps the most important findings beyond the statistically significant improvements for students were that these observed gains were obtained with minimal resources, since in schools, teachers and personnel time is one of the most valuable resources (Christ & Davie, 2009). Minimal training was necessary for implementation with teacher support given. It was also determined that not only is this intervention

effective for accelerating accuracy and fluency progress, but also feasible and it can be scaled for the school/district need.

One of the studies that evaluated a Read Naturally program was conducted by educators who wanted to compare the computer-delivered Read Naturally program and the teacher-guided Six Minute Solution 9 program (Martin, Elfreth & Feng, 2014). Martin and colleagues (2014) used a pre-test/post-test design and showed that after only four weeks of intervention, there was an increase in fluency for both programs, with the Read Naturally program showing a significant higher rate of WCPM. This study is similar in the current dissertation study, as it aimed to compare two programs utilized for fluency intervention, one being computer driven and one being paper based. The discussion around this study is continued later when examining delivery media.

Gibson and colleagues (2014) investigated the effects of Read Naturally Software edition on ORF and comprehension on generalization passages for 8, 1st grade students with reading risk. They used a multiple probe design with two treatment phases. Results showed that ORF and comprehension increased in both phases; however, satisfactory generalization did not occur for most of the participants until the second phase was implemented (Gibson et al., 2014). Gibson and colleagues (2014) note that a benefit of delivering intervention through computer software is that it allows for more independent pupil delivery rather than relying on the teacher which is beneficial when supplemental interventions require time and resources to be implemented properly.

Comparing Methods

With schools facing pressure to meet 100% proficiency under legislative and budgetary restraints, it is important that schools have access to information based in

research when choosing which interventions to use. There is now research based support for both more traditional format interventions that are paper and pencil based, and more technologically advanced interventions such as those that utilize computers or ipads. Given this, it is important that research be conducted to compare these different media formats. Several researchers have taken on this task, and one of these in particular looked at comparing the RNSE version with a different intervention in paper/pencil format.

Martin and colleagues (2014) conducted a study to examine two intervention programs, RNSE (computer assisted) and the Six Minute Solution 9 (teacher-guided). This study was conducted within an elementary school where two programs were utilized for fluency intervention; RNSE and Six Minute Solution. Both programs use similar strategies in that they are largely focused on around repeated reading; however, the six-minute solution is paper based and RNSE is computer driven (Martin et al., 2014). The purpose was to determine which program was most effective in increasing reading fluency. The study was conducted over a four-week period from February to March, 2014 with teacher A and their group receiving RNSE and teacher B and their group receiving Six Minute, each for four days a week with thirty minute sessions.

The Six-Minute solution is a paper based program that uses repeated reading as a strategy for increasing reading fluency. It also involves paired student reading techniques. The program is very similar to RNSE in that it involves a cold read, practicing the same passage, and a hot read. The program begins with an initial teacher conference, then, practicing is done with a buddy and fluency data is graphed onto a chart. Thus, both RNSE and Six Minute involve a comparison from cold to hot timings, repetition, and progress monitoring. RNSE was done on the computer, while Six Minute used paper.

RNSE will not allow a student to progress to the next passage until they have mastered their predetermined goal while students in six minute get to choose a new passage every week. RNSE requires students to work independently while Six Minute requires students to work as partners.

Results showed that students in the RNSE group had a greater increase in reading fluency; however, both programs did result in fluency growth within the short time frame. On average, the RNSE program produced the greatest fluency gain per participant: RN showed an increase on average of 31 words per minute while Six Minute only showed an increase of 3 words per minute. Martin and colleagues (2014) suggest that additional research needs to be conducted to determine if these research based instructional strategies would have different outcomes if used over an extended period of time and utilizing a larger sample of participants.

This study is similar in the current study, as it aimed to compare two programs utilized for fluency intervention, one being computer driven and one being paper based. Martin et al. (2014) point out that additional research would be need to be conducted to determine if these research based instructional strategies would have different outcomes if used over an extended period of time with a larger sample of participants.

While the two programs used the similar strategy of repeated reading as the basis for intervention, they were different. If looking at method of delivery (media used), then research should also be conducted that uses the same program delivered in different ways. The current study aims to compare method of delivery (computer vs. paper-based) using the same program (Read Naturally) to control for other influences, such as difference of program. Since the Read Live web version of Read Naturally has not been

studied in relation to the traditional Read Naturally, it is important to explore this relationship to see if there are differences due to media of delivery so schools can make informed decisions.

CHAPTER 3

METHODOLOGY

The present study was designed to test whether method of delivery of a multi-component reading intervention made a difference in helping to effectively increase oral reading rates for struggling third grade readers. Using a repeated measures research design where students were randomly assigned one of two repeated reading intervention conditions, students' rate of improvement in ORF were examined to test whether differences were observed based on the method of delivery of intervention they received. Additionally, we tested whether differences were observed in vocabulary knowledge, reading comprehension and student engagement between participants in each intervention group. Lastly, we examined whether there were differences in the implementation of the intervention components between the different intervention delivery methods.

Participants and Setting

The population of interest for this study was third-grade students who scored at or below the 40th percentile using an Oral Reading Fluency (ORF) measures. An a priori power analysis was conducted using G-Power software with alpha set at .05 and 1-alpha set at 0.95. Heistad (2005) reported a mean ES of 0.26 (ranging from 0.14 to 0.38) in a study on the effects of Read Naturally on fluency and reading comprehension with a sample of 156 students across four schools and 3 grades. In a RCT evaluating Read Naturally effects, Christ and Davie (2009) used a sample size of 109 and report a mean ES of 0.38 (significant at .05 level) ranging from 0.16 to 0.66 on targeted measures of CBM-R, TOWRE, GORT and WRMT-R. Tucker and Jones (2010) used 20 fourth grade students identified as at risk for reading failure based on their performance on DIBELS

ORF probes in an examination of Read Naturally and reported a mean effect size of 0.71 (ES ranging from .51 to .75 on GORT rate, fluency and accuracy scores). Based on these previous studies, the larger effect size of 0.71 was used to calculate approximate sample size for this study (National Center for Intensive Intervention, n.d.). These parameters indicated that a power of this size would be maintained with a study sample size of 28 students for an ANCOVA statistical analysis.

The actual participants of this study included 22 third grade students from two schools within a Northeastern suburban school district. Students were selected based on an initial pre-test measure of curriculum-based measurement (CBM) Oral Reading Fluency (ORF) administered in the spring of 2nd grade. Students who performed at or below the 40th percentile on the ORF measure qualified for the study. With parent permission for participation, the students were randomly assigned to either receive Read Naturally (traditional version) or Read Live (computer-led version). Despite a recommended sample size of 28 students, after recruitment and consent were completed the total sample for the study was 22 participants.

Of the 22 students in the study, permission was given to obtain demographic information for 21 of the students. 59.1% of the students in the study identified as Caucasian, 4.5% as African American, 9.1% as Asian, and 22.7% identified as Multiracial. 36.4% of the students were identified as being on an Individualized Education Plan, 13.6% were identified as having a 504, and 4.5% were identified as being in the process of being evaluated for eligibility for special education services.

Recruitment and Consent

As universal screening and benchmark assessments were already used in the school district, the school principals, reading teachers, school psychologist and researcher identified students from the spring 2016 benchmark assessment ORF scores whose Spring ORF scores fell below the 40th percentile. A letter was sent home to parents notifying them of the opportunity to participate in the intervention and notifying them about the purpose. Parents had the opportunity to choose whether or not their child(ren)'s participated in this study.

Measures

Oral Reading Fluency

Oral reading fluency (ORF) served as both the initial screening measure from which students were determined eligible for this present study and as an outcome variable to test differences between intervention delivery method. ORF is a one-minute measure to assess fluent text reading. Students read each test probe aloud for 1 minute, and they were scored by calculating the number of correctly read words minus errors per minute. Aimsweb's Reading Curriculum Based Measurement (R-CBM) materials were used for screening and progress monitoring of ORF. Aimsweb reports the average reliability of the median score for ORF screening probes as 0.972 and an average alternate-form reliability of 0.94 across grade levels at each screening period when using single forms. Aimsweb reports the criterion validity to range from 0.70 in grades 3-5 to the mid-to-low 0.60s in Grades 6-8 with state reading tests.

To estimate students rate of improvement using an ordinary least squares analysis, each student in the present study was assessed weekly using a CBM ORF grade level

probes selected from the Aimsweb assessment program (Pearson, 2014). Gain scores were calculated by subtracting the initial ORF progress point from the final ORF progress point. Improving fluency is important for general reading, and it was predicted that while both interventions would improve fluency, the Read Live intervention would result in greater improvements due to predicted greater adherence to intervention implementation..

Generalization Measures

Since improvements to oral reading fluency are highly related to improvements to reading comprehension (Neddenriep et al., 2011; Pikulski & Chard, 2005; Rasinski, 2014), it was also expected that similar gains should occur in more distal reading skills as measured through assessments such as the Aimsweb Plus Reading Comprehension and Vocabulary measures**.** Aimsweb Plus measures are based on extensive scientific research and review, maintaining rigorous psychometric integrity for reliability and validity. Results from several rounds of field-testing were used to revise and refine each measure to ensure the content was clear, fair and unbiased. A large scale national standardization study with more than 20,000 students was undertaken to produce national performance norms and growth norms and confirm the technical adequacy of the Aimsweb Plus assessments. Both the Aimsweb Plus Vocabulary and the Aimsweb Plus Comprehension measures elicit a score based on the raw number of correct responses, which is then converted to a vertical scale called the Growth Scale Value. The vertical scale spans the full performance continuum for Grades 2-8 (aimswebPlus, n.d.).

Aimsweb Plus Vocabulary

The Aimsweb Plus Vocabulary (VO) subtest was designed to be administered three times a year to students in 2nd through 8th grades. To administer the test, students

are asked to identify the meanings of target words by selecting from multiple-choice options. The administration time takes approximately 4-7 minutes. It is aligned to current learning standards (standards-based) and is untimed measure. Aimsweb Plus reported an internal consistent reliability for the Vocabulary measure as 0.73 for third grade measures. The Aimsweb Plus technical manual does not break down composites into separate measures for reporting of validity. Instead, validity is only reported on the Reading Composite score which is derived from combined ORF, Vocabulary, and Reading Comprehension scores. The reported predictive validity was reported to be 0.77 and the reported concurrent validity was reported to be 0.77 for the Aimsweb Plus Reading Composite for third grade measures (Aimsweb Plus, 2015).

Aimsweb Plus Reading Comprehension

The Aimsweb Plus Reading Comprehension (RC) subtest was designed to be administered three times a year to students in 2nd through 8th grades 2-8. To administer this test, students are asked to read six passages of text and answer multiple-choice questions about each passage. The administration time takes approximately 15 to 25 minutes. It is aligned to current learning standards (standards-based) and is untimed measure**.** Aimsweb Plus reported an internal consistent reliability for the Reading Comprehension measure for third grade as 0.87. As previously stated, the Aimsweb Plus technical manual does not break down composites into separate measures for reporting of validity. The Reading Comprehension measure is a part of the Reading Composite that was reported to have a predictive validity of 0.77 and a concurrent validity of 0.77 for third grade measures (Aimsweb Plus, 2015).

Measure of Student Engagement

Within the field of school psychology, student engagement has been conceptualized through different subtypes including: behavioral, academic, cognitive and affective (Carter, Reschly, Lovelace, Appleton & Thompson, 2012). Academic and behavioral engagement are more readily measured through observation (Carter et al., 2012). Research suggests stronger correlations exist between teacher and student reports of low inference subtypes such as behavioral engagement than between teacher and student reports of high inference subtypes such as cognitive and emotional engagement. Because of this, Carter et al. (2012) suggest that "student self-report may be warranted to glean an accurate depiction of cognitive and affective engagement with school". Based on this, a survey created by the researcher was used to examine student reports of engagement. On the survey, students indicated the level to which they agreed with various statements about the program, such as: liking to read, whether Read Naturally had interesting stories, and whether they enjoyed being able to choose the stories they were going to read. The survey can be found in Appendix C.

An additional survey adopted from the "Read Naturally Student Feedback Survey" developed by Linda Butler and Linda Messer (n.d.) that is available from Read Naturally's website was also given. On the survey, students indicated the level to which they agreed with various statement, including: whether they wanted to continue Read Naturally, whether they learned any interested facts while using Read Naturally, and whether they would recommend Read Naturally to other students. The survey can be found in Appendix C.

Measurement of Implementation Integrity

Since Torgesen, et al. (2010) suggested that computer facilitated interventions have the capacity to provide highly specialized instruction with consistent implementation, it was expected that implementation integrity would be facilitated by the computerized intervention method, as access to the intervention components is facilitated by the delivery method itself. Program implementation was measured through calculating the average number of stories completed and the average number of stories partially completed for each group (traditional paper/pencil Read Naturally and computerized Read Live). Each story has a set of steps that are intended to be completed before moving on to the next story. Read Live tracks the completion of steps, and students are locked in until each step is completed before choosing a next story. Read Live reports were used to determine the number of stories completed by students in this condition. Students in the Read Naturally (traditional) condition had folders with their stories in them, along with their graphs of cold and hot timings. The researcher reviewed each folder at the end of the study and counted the number of stories in which all steps were completed as intended and the number of stories were steps were partially completed.

Intervention

Read Naturally

Read Naturally, in the traditional format is implemented with standardized procedures. First, students select a story (most levels include 24 high-interest, nonfiction stores) from their assigned reading level. Then they read key words of the story, write a prediction sentence by using the title, picture and key words, and read the passage

themselves for one minute while marking words they do not know. In the Read Naturally program, this first passage read is called the cold timing read. The students graph their score from this cold timing read in blue on a pre-printed recording form. After the introductory session, students read along to the same passage while listening to an audio CD of the story followed by practice without the audio support. After multiple assisted reading experiences, students then take a brief paper and pencil quiz about the story. Students must read along with the CD at least three times, or until they reach their assigned goal. To graduate from one passages reading level to another, students read to their teacher or aide, and the teacher times the student reading the story and counting errors. To pass, students must reach their goal rate, make no more than 3 errors, read with good expression, and answer the questions correctly. The student then graphs in red the number of words red correct in the "hot" timing.

Read Live

Read Live, a web-based cloud product of Read Naturally, also includes a standardized program procedures. First, students click a picture to select a story to read at their assigned level and read along to an audio reading of the key words of the story. Students click on the words, hear how they are pronounce and then learn about the definitions. As with Read Naturally, students type prediction using the illustration, key words and title to write a sentence about what they think will happen; and then read the passage with a cold timing for 1 minute (students are told to click on any words that are difficult or that they do not know). Read Live subtracts these words from the total number of words read to calculate the baseline score. Students then read along to the story while a computerized narrator reads the story while a highlighted reading guide

directs the student to follow along. This computerized assisted reading occurs at least 3 times with each reading being slightly faster than the prior one. Students can choose to read along again if they feel it is necessary. Students then practice reading the passage independently until they reach a predetermined goal rate. When reached, the program will allow them to move on to the next step where they answer 5 to 9 multiple choice and open ended questions about the story. Students then read the story aloud to the teacher or paraprofessional watching in order to demonstrate that they can read the story at goal rate. To pass, students must reach their goal rate, make no more than 3 errors, read with good expression, and answer the questions correctly. When students pass, a graph is displayed that shows cold and hot timing. If they do not, the teacher assigns the student further practice on the computer and repeats until he or she has passed and can move onto the next story (Read Naturally, n.d.).

Interventionists

Those delivering the intervention were determined by each school in the participating district. Each school identified a building-based contact for the project. In one school, the Title I Reading Specialist was identified to be trained in the intervention. She was joined by a parent volunteer in the building who had a teaching license. In the other building, the principal was identified as the building-based contact and assisted a school psychology practicum student in the running of the intervention. Both schools received additional help with implementation from the primary investigator and other school psychology graduate students.

Procedures

During the first week of October, 2016, the primary researcher met with the Title I Reading Specialist from one school and the principal and school psychologist from the other school to review spring 2016 CBM-ORF bench mark data. All third-grade students who failed to meet the criterion for the 40th percentile on 3rd grade CBM-ORF probes were recruited for participation in the study. For these students, the purpose of the study was explained to their guardians via a letter from the researcher. Active consent was ascertained through a letter home from the schools with a consent form and letter from the researcher. Assent was obtained by the researcher and a school based partner prior to the first intervention session. All participants and their guardians were assured confidentiality in the use of their data. Each student was assigned a random number that resulted in a 50/50 chance of being assigned to either traditional Read Naturally or Read Live.

Students randomly selected to participate in the Read Live intervention completed the Read Live assessment that determined the appropriate starting level based on their reading rate as per Read Live protocol. Students selected for the Read Naturally completed the packaged placement packets which determined the appropriate starting level to start. Interventionists could change the level at any time if they felt it was not an accurate placement (Read Naturally, n.d.). The school based partners were asked to consult the primary researcher before making the switch or if they had any concerns.

The intervention was implemented for 8 weeks (week of October 24th, 2016 to week of December 22th, 2016) in one school and 7 weeks in the other (Week of November 1st to December 22nd, 2016) and weekly progress monitoring of ORF using

district CBM probes each week. In one school, students were divided into two groups consisting of 6 and 7 students. Each group was mixed with students in Read Naturally and students in Read Live. Each group met in the computer lab for 30 minutes, 3 days a week and worked individually with a teacher and the primary researcher or research assistant present. In the other school, students were kept in one group of 11 and worked in the computer lab individually with either the principal and a research assistant or two research assistances present.

All interventionists were given training in Read Naturally or Read Live by the researcher prior to the start of the intervention via reviews of the manual, and reviews of the Read Naturally "How To Videos". The training included the rationale of the intervention, how to complete the steps/what the students will be doing, and how to complete the implementation integrity measures. The research team was available for consultation and questions should they come up during the experiment. Students in both conditions spent the first week with more direct teacher supervision as they learned how to complete the tasks on their own.

Weekly throughout the course of the intervention, the primary investigator and school psychology graduate students completed progress monitoring for all students in the experiment. Progress monitoring was completed using CBM 3rd grade ORF probes. Each student was given 1, 1-minute probe and scored for number of words read correct per minute. Each student's progress was recorded and graphed for the entirety of the intervention.

Fidelity of Implementation

To ensure that the interventions were delivered as intended, interventionists were thoroughly trained and provided with support from the primary investigator. Read Naturally's web-based how-to videos, along with self-study materials (n.d.) were used to deliver the training. Additionally, interventionists received Read Naturally's Lesson Plan and a manual on how to use the materials. Ongoing support was provided through weekly check-ins with the primary investigator. The primary investigator tracked those students placed in Read Live by monitoring their progress through the web-based cloud program. Nineteen sessions were randomly selected and the primary researcher or a research assistant completed an "Intervention Steps Checklist" adopted from "Read Naturally and Read Naturally Live's Fidelity Checklists". These checklists are located in Appendix B. Two items were not applicable in the checklist, as the prediction step and retell step was not used due to time constraints. On average, School 1 completed 13.7 out of 16 steps in the checklist. Percent of completed steps from the checklists will be calculated. School 2 completed on average, 12.3 out of 16 steps in the checklist.

Read Live software automatically records the amount of time students are logged on to and engaged in Read Live software activities. These were examined by the researcher and compared to the planned time of 30 minutes per day, 3 days per week for 8 weeks. Students in the Read Naturally group had their time engaged recorded as a whole by an interventionist for each session (time started Read Naturally, time ended Read Naturally). The planned time for intervention was 30 minutes per day, 3 days per week for 8 weeks. In School 2, four students were only given the intervention 2x a week instead of the planned 3 due to scheduling conflicts.

Data Analysis Plan

Analysis: Rate of Improvement on ORF

Each student's progress monitoring data was converted into a slope using ordinary least squares. CBM-R measures are often administered repeatedly to estimate the rate of improvement for individuals and groups of students (Christ & Davie, 2009). Each progress monitoring point facilitates the analysis of slope by using these to calculate the estimated rate of weekly gain in units of Words Read Correct Per Minute (WRCRM) (Christ & Davie, 2009). The average slopes of Read Live participants were compared with the average slopes of Read Naturally participants using an Analysis of Covariance (ANCOVA) with initial CBM- ORF scores as a covariate to test for statistically significant differences. A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence. Kline (2008, p. 53) notes that ANCOVA works best in experimental designs where groups were formed by random assignment, which is procedure in this study. The data were reviewed to ensure it met the assumption that the covariate and the outcome variable were linear for all groups. ANCOVA assumes homogeneity of regression (Kline, 2008). Data and graphs were reviewed to assure that the assumptions were met and that ANCOVA was still an appropriate form for analysis.

Analysis: Gain Score

A gain store was calculated for each student by subtracting the initial ORF progress monitoring point from the last ORF progress monitoring point. An average gain score was then calculated for each condition. The average gain scores of Read Live (computerized format) participants were compared with the average gain scores of the

Read Naturally (traditional format) participants using an Analysis of Covariance (ANCOVA) with initial CBM-ORF scores as a covariate to test for statistically significant differences. A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence. The data were reviewed to ensure it met the assumptions of an ANCOVA and that an ANCOVA was still an appropriate form for analysis.

Analysis: General Outcome Measures

Aimsweb Plus Vocabulary

The Aimsweb Plus Vocabulary scores of Read Live (computerized format) participants were compared with the scores of the Read Naturally (traditional format) participants using an ANCOVA with initial CBM-ORF scores as a covariate to test for statistically significant differences. The data were reviewed to ensure it met the assumptions of an ANCOVA and that an ANCOVA was still an appropriate form for analysis.

Aimsweb Plus Reading Comprehension

The Aimsweb Plus Reading Comprehension scores of Read Live (computerized format) participants were to be compared with the scores of the Read Naturally (traditional format) participants using an ANCOVA with initial CBM-ORF scores as a covariate to test for statistically significant differences. When the data were reviewed to ensure it met the assumptions of an ANCOVA however, it was determined that an ANCOVA was no longer an appropriate form for analysis due to the violation of the homogeneity of regression assumption. Instead, an Analysis of Variance (ANOVA) was used to test for statistical difference on the Aimsweb Plus Reading Comprehension scores

based on the method of delivery. The data were reviewed to ensure it met the assumptions of ANOVA.

Analysis: Measures of Student Engagement

Student engagement was measured through two surveys, one developed by the researcher and one developed by Butler and Messer (n.d.). Each item was to be compared based on the group of the participants (traditional vs. computerized format) with an ANOVA to determine if there was a difference in student reports based on method of delivery. However, when the data were reviewed to determine if it met the assumptions for ANOVA, the assumptions of normality and homogeneity of variance were violated. Instead, chi-square analyses were used to determine if there was a different in student engagement based on method of delivery.

Analysis: Measures of Program Implementation

Program implementation was measured through examining the number of stories complete and the number of stories partially complete for each student.

Number of Stories Completed

The number of stories completed was calculated for each student by reviewing the reports from Read Live (computerized format) and through reviewing the completed folders for Read Naturally (traditional format) participants. The number of stories completed for Read Live (computerized format) participants were compared with the number of stories completed for the Read Naturally (traditional format) participants using an Analysis of Variance (ANOVA). The data were reviewed to ensure it met the assumptions of an ANCOVA and that an ANCOVA was still an appropriate form for analysis.

Number of Stories Partially Completed

The number of stories partially completed was calculated for each student by reviewing the reports from Read Live (computerized format) and through reviewing the completed folders for Read Naturally (traditional format) participants. The number of stories partially completed for Read Live (computerized format) participants were to be compared with the number of stories partially completed for the Read Naturally (traditional format) participants using an Analysis of Variance (ANOVA). However, when the data were reviewed, it did not meet the assumptions of ANOVA. Since there were large differences in variances between conditions and significant violations of assumptions of normality, the dependent variable was dichotomized so all students who had zero incomplete stories were 0 and all students who had more than 1 incomplete story were 1. $N<5$ in at least one cell, so the Fisher-Exact test was used to examine whether there were differences in number of stories partially completed based on method of delivery.

CHAPTER 4

RESULTS

The purpose of this study was to determine whether the delivery method of a multi-component reading fluency intervention (traditional, paper/audio format vs. computer format) made a difference in increasing the reading fluency rate of third-grade participants over an 8-week intervention period. ORF was measured through progress monitoring using Aimsweb CBM ORF probes and converted to slope of ordinary least squares to determine rate of weekly improvement. Data were also collected on gain scores (final progress monitoring point minus initial progress monitoring point), vocabulary and reading comprehension, number of stories completed from the program, and number of stories that were partially completed from the program. Additionally, the study also examined whether method of delivery of the reading intervention had different effects on student engagement, as measured through student survey reports.

It was hypothesized that all students would approximate typical or ambitious rates of achievement on ORF, regardless of the model of delivery. The researchers hypothesized however, that due to predicted greater implementation integrity in the Read Live program, that students in the computerized deliver model would have better outcomes. It was also hypothesized that these rates would approximate expected rates of improvement within a typical population. Additionally, it was hypothesized that students assigned to the computerized intervention would report that they were more engaged than students who were assigned to the traditional format, as measured through surveys at the conclusion of the intervention. The study utilized a randomized experimental repeated measures design to test these differences. Analysis of Covariance (ANCOVA) was used

with initial ORF scores as the covariate to test for statistically significance differences in rate of improvement and gain scores. Analysis of Variance (ANOVA) was used to test for differences in number of stories complete and a Fischer Exact Test was used to test for differences in number of stories partially complete based on delivery method.

Descriptive Statistics

Table 1 provides descriptive statistics for the dependent variables that were analyzed to assess differences in students' response to the intervention method in the study, including initial ORF, gain score, slope of improvement, and post-test scores for Aimsweb vocabulary and Aimsweb Reading comprehension. Table 1 also includes the dependent variables that estimated differences in intervention implementation due to intervention method, including stories complete and stories partially complete (incomplete) for the Read Live (computer) and Read Naturally (paper) group.

Rate of Improvement

Analyses of Underlying Assumptions

ANCOVA was used to evaluated whether differences in the rate of improvement for ORF differed between groups based on intervention delivery method. The data set was examined in relation to the assumptions of ANCOVA including, that the observations of the dependent variable are normally distributed, that there is a linear relationship between the dependent variable and covariate for each level of the independent variable, that there is homogeneity of regression slopes, that there is homogeneity of variance, and that are no outliers. The skewness of the rate of improvement (OLS Slope) was 0.988 (SE=0.501) which falls within the +/-1 range, indicating the rate of improvement outcome was approximately normal. The kurtosis of

the rate of improvement outcome was 2.203 (SE=0.972) which does not fall within the +/- 1 range for normality, suggesting some kurtosis in the data. Examination of the histogram and Normal Q-Q plots (Figure 1, Appendix D) also illustrates skewness within bounds of acceptable and a leptokurtic distribution. However, neither the Kolmogorov-Smirnov nor Shapiro-Wilk statistics were significant, which suggests normality appropriate for a computing an ANCOVA. An ANOVA was conducted between initial ORF and method of delivery (computer or paper) and was not significant, indicating that the initial ORF could be used as a covariate in the model as there was no treatment by covariate interaction. Examination of the histogram and Normal Q-Q plot for the initial ORF (covariate) were completed (Figure 2). A preliminary analysis evaluating the homogeneity of regression assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable (α=.05), $F(1,20)=2.913$, p=.106). The Levine statistic was not significant, suggesting homogeneity of variance. The outcome variable is continuous and students were randomly divided into two independent groups with no student participating in both groups. Lastly, there was an outlier (Figure 1); however, tests were run with and without the outlier, and presence or absence of the outlier did not change the results.

Findings

Since the assumptions were met, an ANCOVA was used to evaluated whether significant differences were observed in the observed rates of improvement for students in differed intervention conditions. A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence.

The independent variable, method of delivery, included two levels: Read Live (computer format) or Read Naturally (paper format). The dependent variable was the students' rate of improvement in ORF and the covariate was the students' initial ORF score. The mean (SD) rate of improvement score for students in the Read Live condition (computer format) and the Read Naturally condition (paper format) were 2.065 (1.899) and 0.829 (1.188) which were not significantly different from one another (α=.05) $F(1, 18)=3.936$, $p=.063$ (Table 2). However, the Cohen's effect size value ($d=.76$) suggested moderate practical significance.

Gain Score

Analyses of Underlying Assumptions

Data estimating the gain score differences were assessed to evaluate that this dependent variable met the assumptions of normality. The skewness of the gain score outcome was -0.573 (SE=0.501) which falls within the +/- 1 range; the kurtosis of the gain score outcome was -0.138 (SE=0.972) and falls within the range of +/-1, both estimates indicate that the distribution was approximately normal. Neither the Kolmogorov-Smirnov nor Shapiro-Wilk statistics were significant, and a visual examination of the histogram and Normal Q-Q plot (Figure 3) also provide evidence that the distribution is approximately normal. A preliminary analysis evaluating the homogeneity of regression assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable (α=.05), $F(1,20)=0.177$, $p=.680$). An ANOVA was conducted between initial ORF and method of delivery (computer or paper) and was not significant, indicating the initial ORF could be used as a covariate in the model as there was no

treatment by covariate interaction. The Levine statistic was not significant, suggesting homogeneity of variance. The outcome variable is continuous, and students were randomly divided into two independent groups with no student participating in both groups. There were no outliers (Figure 3).

Findings

Since the assumptions were met, an ANCOVA was used to assess whether differences were observed in the ORF gains between the two intervention groups. A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence. The independent variable, method of delivery, included two levels: Read Live (computer format) or Read Naturally (paper format). The dependent variable was the students' Gain Score and the covariate was the students' initial ORF score. The ANCOVA was significant. The mean (SD) gain score for students in the Read Live condition (computer format) and the Read Naturally condition (paper format) were 14.182 (12.172) and 2.200 (15.775) respectively, which was statistically significant (α=.05), $F(1,18)=6.538$, p=.020 (see Table 3). A measure of association (omega squared) was calculated and 15.5% of the total variance in gain score was accounted for by the method of delivery controlling for the students' initial ORF. Further, Cohen's effect size value (d=.86) suggested a high practical significance.

Generalized Outcome Measures

Aimsweb Plus Vocabulary

Students who participated in the intervention were also administered the Aimsweb Plus Vocabulary measures. Twenty students were administered the assessment. One student was absent and another student moved. Three of the students were observed to

randomly select answers throughout the measure, thus their scores are not considered valid and were not included in the analysis (n=17). Of the 17, 9 students were in the Read Live (computer group) and 8 were in the Read Naturally (paper group).

Analyses of Underlying Assumptions

Data estimating the Aimsweb Plus Vocabulary scores were assessed to evaluate that this dependent variable met the assumptions of normality. The skewness of the Aimsweb Plus Vocabulary outcome was 1.032 (SE=0.550) which falls just outside the +/- 1 range; the kurtosis of the Aimsweb Plus Vocabulary outcome was 2.156 (SE=1.063) and falls outside of the range of +/-1. It does however fall just outside the typically acceptable range of +/-2. Neither the Kolmogorov-Smirnov nor Shapiro-Wilk statistics were significant for the computer group; however, they were significant for the paper group. A visual examination of the histograms and Normal Q-Q plots (Figure 4) also provide evidence that the distribution is approximately normal. A preliminary analysis evaluating the homogeneity of regression assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable (α=.05), $F(1,15)=4.279$, p=.061). An ANOVA was conducted between initial ORF and method of delivery (computer or paper) and was not significant, indicating the initial ORF could be used as a covariate in the model as there was no treatment by covariate interaction. The Levine statistic was not significant, suggesting homogeneity of variance. The outcome variable is continuous, and students were randomly divided into two independent groups with no student participating in both groups. Outliers were detected (Figure 4) but did not influence the findings.

Findings

Since the assumptions were met, an ANCOVA was used to evaluated whether significant differences were observed on the Aimsweb Plus Vocabulary measure for students in differed intervention conditions. A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence. The independent variable, method of delivery, included two levels: Read Live (computer format) or Read Naturally (paper format). The dependent variable was the students' score on the Aimsweb Plus Vocabulary measure and the covariate was the students' initial ORF score. The mean (SD) Aimsweb Plus Vocabulary score for students in the Read Live condition (computer format) and the Read Naturally condition (paper format) were 183.44 (17.089) and 182.250 (22.995) which were not significantly different from one another (α=.05), $F(1, 13)=0.008$, p=.929 (Table 4). Further, the Cohen's effect size value (d=.05) suggested limited practical significance.

Aimsweb Plus Reading Comprehension

Students who participated in the intervention were also the administered Aimsweb Plus Reading Comprehension measure. Twenty students were administered the assessment. One student was absent and another student moved. Three of the students were observed to randomly select answers throughout the measure, thus their scores are not considered valid and were not included in the analysis (n=17). Of the 17, 9 students were in the Read Live (computer group) and 8 were in the Read Naturally (paper group).

Analyses of Underlying Assumptions

Data estimating the Aimsweb Plus Reading Comprehension scores were assessed to evaluate that this dependent variable met the assumptions of ANCOVA. Normality

was examined. The skewness of the Aimsweb Plus Reading Comprehension outcome was 0.306 (SE=0.550) which falls within the +/- 1 range; the kurtosis of the Aimsweb Plus Reading Comprehension outcome was 0.137 (SE=1.063) and falls within of the range of +/-1. Neither the Kolmogorov-Smirnov nor Shapiro-Wilk statistics were significant, suggesting normality. A visual examination of the histogram and Normal Q-Q plot (Figures 5) also provide evidence that the distribution is approximately normal. A preliminary analysis evaluating the homogeneity of regression assumption indicated that the relationship between the covariate and the dependent variable did differ significantly as a function of the independent variable (α=.05), $F(1,12)=6.171$, p=.029); thus, the homogeneity of regression assumption is violated. An ANOVA was conducted between initial ORF and method of delivery (computer or paper) and was not significant, indicating the initial ORF could be used as a covariate in the model as there was no treatment by covariate interaction. The Levine statistic was not significant, suggesting homogeneity of variance. The outcome variable is continuous, and students were randomly divided into two independent groups with no student participating in both groups. There were no outliers observed in the data (Figure 5).

Findings

Due to the violation of the homogeneity of regression assumption, an ANCOVA could not be computed. Instead an ANOVA was computed. A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence. No statistical difference on Aimsweb Plus Reading Comprehension scores based on method of delivery was observed in this intervention study. The mean (SD) Aimsweb Plus Reading Comprehension score obtained by students

in the Read Live (computer version) and Read Naturally (traditional format) was 174.556 (20.427) and 163.375 (17.171) respectively, which was not statistically significant different (α=.05), $F(1,15)= 1.470$, p=.244 (see Table 5). The Cohen's effect size value (d=.59) suggested moderate practical significance.

Measures of Student Engagement

Student engagement was measured through two surveys. One developed by the researcher and one developed by Butler and Messer (n.d.) accessed from Read Naturally's website (See Appendix C). Both surveys used a Likert scale format. Descriptive statistics are presented in Tables 8 and 9. Students' responses are presented in Tables 10 and 11 along with percentages of the total sample (n=21). Survey data was obtained from 21 of the 22 students. Chi-Squared tests were performed as most questions did not meet the normality and homogeneity of variance assumptions of ANOVA. There were no statistically significant findings on either survey (Tables 10 and 11).

Measures of Implementation Integrity

Number of Stories Completed

Analyses of Underlying Assumptions

An Analysis of Variance (ANOVA) test used to test whether delivery method significantly affected implementation fidelity of the Read Naturally programs. Using the number of stories completed and the number of stories partially completed by students as the dependent variable, we hypothesized that the ease of the computer facilitated intervention would enable greater adherence to the intervention procedures than the teacher-facilitated intervention format.

For the number of stories complete, the data met all underlying assumptions necessary for conducting an ANOVA. The outcome variable is continuous, students were randomly divided into two independent groups, no student participated in both groups, and there were no significant outliers. Normality was tested, the skewness of the number of stories complete outcome was 0.181 (SE= 0.491), which falls within the +/- 1 range, indicating the distribution is approximately normal. The kurtosis of the number of stories completed was -0.521 (SE=0.953) and falls within the range of +/- 1, indicated the distribution is approximately normal. Neither the Kolmogorov-Smirnov or Shapiro-Wilk statistics were significant, and an examination of the histogram and Normal Q-Q plot (Figures 23 and 24) also indicate the distribution is approximately normal. Finally, the Levine statistic was not significant, suggesting homogeneity of variance.

Findings

A one-tailed test was used due to the direction of the predicted outcome, with a rejection area of .05 in one-tail to maintain 95% confidence. No statistical difference in number of stories completed based on method of delivery was observed in this intervention study. The mean (SD) number of stories completed during the intervention for students in the Read Live (computer version) and Read Naturally (traditional format) was 11.00 (1.54) and 6.90 (1.16) respectively, which was not a statistically significant different (α=.05), $F(1,20)= 4.236$, p=.053 (see Table 6). The Cohen's effect size value (d=3.05) suggested large a practical significance.

Number of Stories Partially Completed

The mean (SD) number of stories that were partially completed during the intervention for students in the Read Live (computer version) and Read Naturally

(traditional format) was 0(0) and 3.100 (3.872), respectively. The variances for students was 0.000 for students in Read Live and 14.989 for students in Read Naturally. No student on the computer version was able to leave a story incomplete before moving onto the next story, as reflected in the mean. Students who worked in the paper format were not directed by the computer program, and had to rely on following steps on their own or asking the interventionist. This meant that some students moved onto another story before completing a story in its entirety. Qualitatively, this portrayed two different outcomes based on which intervention format the students were assigned to. The data were also examined to determine whether or not they were statistically significant.

Analyses of Underlying Assumptions

In order to examine whether method of delivery affected the number of stories partially completed, the data was examined to see whether it met the assumptions of ANOVA. The outcome variable is continuous and students were randomly divided into two independent groups with no student participating in both groups; however, when normality was tested, the skewness of number of partially complete stories was 2.689 (SE= 0.491), which does not fall within the +/- 1 range, indicating that the distribution is not normal. The kurtosis of number of partially complete stories was 7.504 (SE=0.953), which also does not fall within the +/- 1 range, indicating that the distribution is not normal. Examination of the histogram and Normal Q-Q plot (Figure 6) also indicate the distribution is not normal. Group variances also different, as the variance for students on the computer format was 0.000 and the variance for students in the paper format was 14.989.

Findings

Because of this, the underlying assumptions of ANOVA were not met. Instead, the dependent variable was dichotomized, so that all students who had zero incomplete stories were 0 and all students who had more than 1 incomplete story were 1. Since n <5 in at least once cell (see Table 7), the Fisher-Exact test was used. Students who used Read Naturally (paper) were significantly more likely to have partially completed stories in their packets (p=.007, effect size= .70). The mean (SD) number of stories partially completed during the intervention for students in the Read Live (computer version) and Read Naturally (traditional format) was 0 (0) and 3.10 (3.872) respectively.

Table 1. Descriptive Statistics

		Student Outcome Data					Program Implementation	
		Initial ORF	Gain Score	Slope Per Week	Aimsweb+ Vocab.	Aimsweb+ Reading Comp	Stories Complete	Stories Incomplete
Computer Format (n=12)	Mean	69.454	14.182	2.065	183.444	174.556	11	0
	(SD)	(22.633)	(12.172)	(1.899)	(17.089)	(20.427)	(5.326)	(0)
	Kurtosis	-0.373	-1.287	1.276	-0.492	-0.037	-0.484	
	Skewness	-0.541	-0.432	0.955	-0.204	0.478	-0.303	
Paper Format (n=10)	Mean	67.500	2.200	0.829	182.250	163.375	6.900	3.100
	(SD)	(24.627)	(15.775)	(1.188)	(22.995)	(17.171)	(3.665)	(3.872)
	Kurtosis	0.278	-0.205	0.298	4.714	-0.963	-0.481	2.286
	Skewness	0.881	-0.392	-0.543	1.780	-0.384	-0.137	1.600

Table 2. Analysis of Co-Variance for Rate of Improvement by Method of Delivery

Source	*SS*	*df*	*MS*	*F*	*p*
Initial ORF	8.849	1	8.849	3.3992	0.061
Delivery Method	8.726	1	8.726	3.936	0.063
Error	39.900	18	2.217		
Total	56.743	20			

Table 3. Analysis of Co-Variance for Gain Score by Method of Delivery

Source	*SS*	*df*	*MS*	*F*	*p*
Initial ORF	1402.220	1	1402.220	10.884	0.004
Delivery Method	842.373	1	842.373	6.538	0.020
Error	2319.017	18	128.834		
Total	4473.238	20			

Table 4. Analysis of Co-Variance for Aimsweb Plus Vocabulary by Method of Delivery

Source	*SS*	*df*	*MS*	*F*	*p*
Initial ORF	485.463	1	485.463	1.154	0.302
Delivery Method	3.502	1	3.502	0.008	0.929
Error	5469.912	13	420.762		
Total	540685.000	16			

Table 5. Analysis of Variance for Aimsweb Plus Reading Comprehension by Method of Delivery

Source	*SS*	*df*	*MS*	*F*	*p*
Between Groups	529.432	1	529.432	1.470	0.244
Within Groups	5402.097	15	360.140		
Total	5931.529	16			

Table 6. Analysis of Variance for Number of Stories Completed by Method of Delivery

Source	*SS*	*df*	*MS*	*F*	*p*
Between Groups	91.691	1	91.691	4.235	0.053
Within Groups	432.900	20	21.625		
Total	524.591	21			

Table 7. 2x2 For Method of Delivery and Number of Incomplete Stories

Number of Incomplete Stories	Computer Format		Paper Format
Totals			
0	12	3	15
1 or More	0	7	7
Totals	12	10	22

Table 8. Descriptive Statistics for Researcher's Survey

	Mean	Standard Deviation	Variance	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Method of Delivery	1.476	0.5118	0.262	0.103	0.501	-2.211	0.972
I like to read	1.524	0.6796	0.462	0.962	0.501	-0.102	0.972
Reading is boring	3.571	0.5976	0.357	-1.078	0.501	-0.348	0.972
I like being read to	1.857	1.1084	1.229	0.795	0.501	-0.950	0.972
RN has interesting stories	2.048	1.2032	1.448	0.662	0.501	-1.168	0.972
I like being able to choose what story	1.190	0.4024	0.162	1.700	0.501	0.975	0.972
I have fun while doing RN	1.667	0.8416	0.708	1.223	0.501	1.339	0.972
I want to try hard while doing RN	1.190	0.6796	0.462	3.974	0.501	16.360	0.972

Table 9. Descriptive Statistics for Butler and Messer's (n.d.) Survey

	Mean	Standard Deviation	Variance	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Method of Delivery	1.476	0.5118	0.262	0.103	0.501	-2.211	0.972
Improved my Fluency	1.528	0.8047	0.648	1.739	0.501	3.247	0.972
Other books get easier	1.571	0.9284	0.862	1.581	0.501	1.317	0.972
I want to continue RN	1.571	1.1212	1.257	1.685	0.501	1.204	0.972
I am a better reader than I used to be	1.190	0.5118	0.262	2.829	0.501	7.918	0.972
I am more willing to read aloud	1.950	0.9445	0.892	0.940	0.512	0.405	0.972
RN is easy to do	1.524	0.9284	0.862	1.581	0.501	1.317	0.972
I would recommend RN to other students	1.714	1.1019	1.214	1.128	0.501	-0.340	0.972
Interesting Passages	1.524	0.8136	0.662	1.147	0.501	-0.394	0.972
Learn interesting facts	1.667	1.1106	1.233	1.470	0.501	0.705	0.972

Table 10. Results from Researcher's Survey

Results of Chi-square Test for "I like to read" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	5 (23.8%)	4 (19%)	2 (9.5%)	0 (0%)
Paper	7 (33.3%)	3 (14.3%)	0 (0%)	0 (0%)

Note. $\chi^2 = 2.434$, df = 2. Numbers in parentheses indicate column percentages.
p =0.296

Results of Chi-square Test for "Reading is boring" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	0 (0%)	1 (4.8%)	5 (23.8%)	5 (23.8%)
Paper	0 (0%)	0 (0%)	2 (9.5%)	8 (38.1%)

Note. $\chi^2 = 2.937$, df = 2. Numbers in parentheses indicate column percentages.
p =0.230

Results of Chi-square Test for "I like being read to" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	5 (23.8%)	1 (4.8%)	3 (14.3%)	2 (9.5%)
Paper	7 (33.3%)	1 (4.8%)	2 (9.5%)	0 (0%)

Note. $\chi^2 = 2.491$, df = 3. Numbers in parentheses indicate column percentages.
p =0.477

Results of Chi-square Test for "RN has stories that are interesting to me" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	6 (28.6%)	1 (4.8%)	2 (9.5%)	2 (9.5%)
Paper	4 (19%)	3 (14.3%)	1 (4.8%)	2 (9.5%)

Note. $\chi^2 = 1.690$, df = 3. Numbers in parentheses indicate column percentages.
p =0.639

Results of Chi-square Test for "I like being able to choose what story I am going to read" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	9 (42.9%)	2 (9.5%)	0 (0%)	0 (0%)
Paper	8 (38.1%)	2 (9.5%)	0 (0%)	0 (0%)

Note. Numbers in parentheses indicate column percentages. A Fisher-Exact test was completed due to having only a 2x2 results, were non-significant (p=1.000).

Results of Chi-square Test for "I have fun while doing RN" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	6 (28.6%)	3 (14.3%)	1 (4.8%)	1 (4.8%)
Paper	5 (23.8%)	5 (23.8%)	0 (0%)	0 (0%)

Note. $\chi^2 = 2.716$, df = 4. Numbers in parentheses indicate column percentages.
p =0.606

Results of Chi-square Test for "I want to try hard while doing Read Naturally" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	9 (42.9%)	1 (4.8%)	0 (0%)	1 (4.8%)
Paper	10 (47.6%)	0 (0%)	0 (0%)	0 (0%)

Note. $\chi^2 = 2.010$, df = 2. Numbers in parentheses indicate column percentages.
p =0.366

Table 11. Results from Butler and Messer (n.d.) Survey

Results of Chi-square Test for "Read Naturally has improved my reading fluency" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	6 (28.6%)	3 (14.3%)	1 (4.8%)	1 (4.8%)
Paper	7 (33.3%)	3 (14.3%)	0 (0%)	0 (0%)

Note. $\chi^2 = 2.959$, df = 4. Numbers in parentheses indicate column percentages.
p =0.565

Results of Chi-square Test for "When I read other books, I can tell I am improving because they get easier" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	7 (33.3%)	0 (0%)	3 (14.3%)	1 (4.8%)
Paper	8 (38.1%)	2 (9.5%)	0 (0%)	0 (0%)

Note. $\chi^2 = 6.033$, df = 3. Numbers in parentheses indicate column percentages.
p =0.110

Results of Chi-square Test for "I want to continue Read Naturally" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	9 (42.9%)	0 (0%)	0 (0%)	2 (9.5%)
Paper	7 (33.3%)	1 (4.8%)	1 (4.8%)	1 (4.8%)

Note. $\chi^2 = 2.541$, df = 3. Numbers in parentheses indicate column percentages.
p =0.468

Results of Chi-square Test for "I am a better reader than I used to be" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	9 (42.9%)	1 (4.8%)	1 (4.8%)	0 (0%)
Paper	9 (42.9%)	1 (4.8%)	0 (0%)	0 (0%)

Note. $\chi^2 = 0.955$, df = 2. Numbers in parentheses indicate column percentages.
p =0.620

Results of Chi-square Test for "I am willing to read out loud more than I used to be" by Method of Delivery

Method of Delivery	Rating			
	Very Much	Pretty Much	Just a Little	Not at All
Computer	4 (20%)	5 (25%)	2 (10%)	0 (0%)
Paper	3 (15%)	4 (20%)	0 (0%)	2 (10%)

Note. $\chi^2 = 4.095$, df = 3. Numbers in parentheses indicate column percentages.
p =0.251

Results of Chi-square Test for "Read Naturally is easy to do" by Method of Delivery

Method of	Rating			
Delivery	Very Much	Pretty Much	Just a Little	Not at All
Computer	9 (42.9%)	1 (4.8%)	0 (0%)	1 (4.8%)
Paper	6 (28.6%)	1 (4.8%)	3 (14.3%)	0 (0%)

Note. $\chi^2 = 4.563$, df = 3. Numbers in parentheses indicate column percentages.
p =0.207

Results of Chi-square Test for "I would recommend Read Naturally to other students" by Method of Delivery

Method of	Rating			
Delivery	Very Much	Pretty Much	Just a Little	Not at All
Computer	6 (28.6%)	0 (0%)	3 (14.3%)	2 (9.5%)
Paper	8 (38.1%)	1 (4.8%)	1 (4.8%)	0 (0%)

Note. $\chi^2 = 4.248$, df = 3. Numbers in parentheses indicate column percentages.
p =0.236

Results of Chi-square Test for "Read Naturally uses interesting passages" by Method of Delivery

Method of	Rating			
Delivery	Very Much	Pretty Much	Just a Little	Not at All
Computer	8 (38.1%)	0 (0%)	3 (14.3%)	0 (0%)
Paper	6 (28.6%)	3 (14.3%)	1 (4.8%)	0 (0%)

Note. $\chi^2 = 4.238$, df = 2. Numbers in parentheses indicate column percentages.
p =0.120

Results of Chi-square Test for "I often learn interesting facts when I read the passages" by Method of Delivery

Method of	Rating			
Delivery	Very Much	Pretty Much	Just a Little	Not at All
Computer	8 (38.1%)	1 (4.8%)	1 (4.8%)	1 (4.8%)
Paper	6 (28.6%)	2 (9.5%)	0 (0%)	2 (9.5%)

Note. $\chi^2 = 1.909$, df = 3. Numbers in parentheses indicate column percentages.
p =0.591

CHAPTER 5

DISCUSSION

The present investigation examined whether the delivery method of a multicomponent reading fluency intervention (traditional vs. computer led) had different effects on the reading rates of third grade students over a short-term intervention period. In addition to reading rate, this study examined whether differences were observed in more distal reading outcomes, including vocabulary knowledge and reading comprehension, between the students in the two intervention groups. It was also hypothesized that student involved in the computer assisted platform would report more motivation and engagement than students in the traditional paper-pencil method, and that better intervention implementation integrity would be observed for the delivery of the computer assisted program than the tradition Read Naturally method.

Reading fluency, including both rate and accuracy, serves as a necessary skill for successful readers (Adams, 1990; Hasbrouck et al., 1999; National Reading Panel, 2000). Readers who struggle with fluency often stumble over words, read slowly, and read with fractured sentence structures that lead to difficulty in understanding the meaning of what they are reading (Allington, 1983; Biancarosa & Cummings, 2015; Carnine et al., 1997; Hasbrouck et al., 1999; Reutzel & Hollingsworth, 1993). Importantly, improvements to reading fluency have been found to be positively correlated with improvements to reading comprehension, (Neddenriep et al., 2011; Pikulski & Chard, 2005; Rasinski, 2014), so this study included an analysis of vocabulary knowledge and reading comprehension differences between the two intervention groups to examine if differences

in word reading efficiency that may occur between the two groups resulted in differences in higher order reading and thinking skills.

There are several research-supported strategies for improving fluency that are found in the literature, including: reading with a model/listening to a fluent reader, repeated readings of the same text, and progress monitoring with feedback (Hasbrouck et al., 1999), all of which are incorporated into Read Naturally's intervention model. Because reading fluency is necessary for proficient reading, and laws and regulations have codified accountability that include the expectation of success for all students using evidence based interventions, the development and use of evidence based interventions designed to improve reading fluency is necessary for educational improvement efforts.

Schools and teachers already face a range of challenges when choosing a strategy for intervention, as they try to incorporate research findings into classroom practice where a wide range of student abilities, skill levels and needs exist (Hasbrouck et al., 1999). Advances in computer assisted teaching methods, literacy instruction and communication technology have resulted in the development and exploration of many more new possibilities for educational programs, including interventions for reading and literacy skills. While these developments have the potential to combat some of the resources limitations schools are facing in order to provide additional, intensive instruction to students who are struggling, there is a need for more research that examines under which conditions computers can be used effectively to help prevent and remediate reading difficulties in students. Since the Read Live web version of Read Naturally has not been studied in relation to the traditional Read Naturally format, it was deemed important to explore this relationship to see if there are differences due to delivery

method so schools can make informed decisions around how to use their limited resources with interventions.

Summary of Findings

Rate of Improvement and Gain Scores

It was hypothesized that the rate of improvement (ROI) on ORF will approximate typical or ambitious rates in both delivery formats based on Hasbrouck and colleagues (1999) study where students in a traditional Read Naturally format approximated typical or ambitious rates of achievement on ORF. While this suggests that students in both groups would make improvements, it was hypothesized that students in the Read Live condition would make greater improvements due to the prediction that their intervention would be completed with more integrity. It was also hypothesized that these rates would approximate the expected rate of improvement within a typical population. In this study, students in the computerized Read Live group achieved an average ROI of 2.065 (SD=1.899) words per week while students in the traditional paper-format Read Naturally group achieved an average ROI of 0.829 (SD=1.188) words per week. Students whose curriculum based measurement benchmark scores are estimated at the 10^{th} percentile have a typical ROI of 0.8 words per week, while students at the 25^{th} have a typical ROI of 1.1 words per week and the 50^{th} have a typical ROI of 1.2 words per week (Hasbrouck & Tindal, 2005). Students in this study fell in between the 10^{th} and 40^{th} percentiles, so average ROIs for both groups fell at least within the expected range. The average ROI from the computerized group is 1.7x the expected ROI for a student at the 50^{th} percentile. However, results from this study indicate that there were no statistical differences in ROI between groups. Although there were not statistical differences in ROI between groups,

students in the computerized format did have significantly higher gain scores than those in the traditional paper format. This may be due to the variability of improvement for students from week to week. These results suggest that students in the Read Live (computerized format) did make more improvements than students in the traditional delivery format, as measured through gain scores, as was hypothesized.

Generalization Measures

Research suggests reading fluency is strongly correlated with comprehension (Biancarosa & Cummings, 2015). When reading subskills such as decoding are performed automatically, higher order aspects such as comprehension can be performed effectively at the same time (Samuels & Flor, 1997). Thus, with improved fluency, it is expected that there will be more cognitive attention available for higher order thinking skills that are required for comprehension and vocabulary knowledge, which should result in improvements in those areas. Data on the generalization outcome measures were also collected through Aimsweb Plus Vocabulary and Reading Comprehension curriculum based measurements. For students in this study, their Aimsweb Plus Vocabulary and Reading Comprehension outcome measures did not differ significantly based on the method of delivery they received the intervention through. No baseline data was available to examine student improvement on these measures in general based on being in the intervention regardless of method of delivery.

However, since the program procedures focus primarily on accuracy and fluency skills, it would not necessarily be expected that students would make significant gains in areas such as comprehension over such a brief period of implementation; instead, comprehension gains would be expected over a more extended period of intervention

(Christ & Davie, 2009). It is also important to note that the prediction and retell options were not implemented in the Read Naturally program for this study, which could also influence vocabulary and comprehension performance beyond the in-program quizzes. A follow-up study may include these components and/or increase the time of implementation with baseline vocabulary and comprehension data available in order to examine how method of delivery influences these generalization measures.

Student Engagement Measures

Student engagement in this study was measured through student self-report surveys. It was hypothesized that students assigned to the computer-facilitated intervention would express that they were more engaged than those students who were assigned to the traditional format. Results of this study indicate that the students survey responses did not differ significantly based on the assigned method of delivery. It is possible that students may have answered the questions in a way as though they felt they should rather than their true opinions. While there were no statically significant differences on the survey findings, anecdotal observations portrayed a different picture where students assigned to the computer-facilitated intervention appeared to be more on-task. Interventions were also noticed to frequently inform the researcher that the computers were “so much easier”. A future study may also include teacher and interventionist surveys, along with structured direct observations designed to measure student engagement.

Number of Stories Complete/Partially Complete

It was hypothesized that the ease of the computer facilitated intervention would enable greater adherence to the intervention procedures than the traditional paper format

that requires more teacher-facilitation. This was examined through measuring the number of stories completed and the number of stories partially completed by students based on delivery method group. No statistically signification differences were observed for the number of stories that were completed between the two intervention groups. However, a Fisher-Exact Test revealed that there was a significant difference between the two groups for the number of stories there were partially completed. Therefore, significantly less stories were completed with the integrity of the intervention components for Read Naturally than were completed using Read Live. Students who were in the computer-facilitated intervention group could not move on from a story until they completed all required parts while students in the traditional paper format were not held in a locked sequence format. Students in the traditional a paper format may have accidently skipped a step that went unnoticed by the interventionist or started a new story without finishing all the steps of the old story. The computer version would also remember where a story left off so they could start in the same place the next time they returned to intervention. Students in the traditional paper group often relied on the interventionist and/or sticky notes written by the interventionist to remind them of what step they were on. Therefore, as predicted, the computer facilitated intervention resulted in the delivery with better treatment integrity than the face to face intervention method.

Thus, it is no surprise that number of stories partially completed differed significantly based on method of delivery as students in the computer-facilitated version had no incomplete/partially complete stories. While the number of stories complete is close to reaching significance, it is not considered significant. This may be due to students in the traditional format quickly moving from story to story; perhaps starting a

story and moving to a next one before completing it. They still completed a similar number of stories, but additionally had more stories which they left partially completed. A future study may examine student outcomes while utilizing smaller intervention groups so the interventionist has more direct one-on-one contact with students in the traditional format to ensure that steps are followed. Regardless, as we hypothesized, results from this study indicate that the ease of the computer-facilitated format enabled greater adherence to the intervention procedures.

Limitations and Future Directions

Several limitations are noted. First, this study was conducted with a small sample size, that also only consisted of 3rd grade students, limiting generalizability of the findings. The small sample size also resulted in low power, which could have resulted in a Type II error. Future studies may include a larger sample size to not only increase generalizability but also increase power and decrease the likelihood of a Type II error.

There was a significant reliance on graduate student assistants for delivery in one school, and in the other school, the intervention was run solely by a graduate student assistant. Future research should be completed that evaluates the efficacy of interventions when delivered by in school personnel. All students also used computers: the students on Read Live (computer format) completed the entire intervention through a program on the computer while students in Read Naturally (paper format) used the computer to play the audio CDs while reading and writing on paper and using a timer. Future studies may look at other forms of audio used in schools for students listening in Read Naturally. Additionally, time slots were set aside for the intervention to be completed. In many schools, the intervention is done within the classroom or apart of activity rotations such

as learning centers. Research should be completed to see how method of delivery may influence outcomes across various push-in and pull-out instructional settings. Additionally, Read Naturally was completed at the minimal amount of recommended time (3x a week for 30 minutes at a time). Future research should be conducted to evaluate influence of method of delivery with more frequent intervention. There was also evidence of lack of implementation fidelity in this study. Some students only attended two sessions a week. Also, students who participated in the paper-format were able to skip steps that at times went unnoticed by the interventionist due to a larger group sizes (i.e. 8 students). Interestingly, with the low commitment by the schools' staff to implement this supplemental intervention, we found that students in the computer assisted medium experienced better treatment fidelity than those in the traditional delivery method. This finding is important for selected intervention programs in schools where little commitment or resistance to implementing supplemental instructional efforts are the commonplace.

It should be also noted that there are also a Phonics Series and an Idiom Series available through Read Naturally. This study only used the Sequenced Series. Research can be conducted to evaluate whether there is a difference in delivery method for student outcomes for the Phonics Series and/or Idioms Series. As procedure in this study due to time constraints and school partner preference, the prediction and retell portions of the intervention (which are optional) were not included. Future studies may examine the influence of method of delivery when these components are included.

Finally, there are some limitations regarding outcome measures. First, students were progress monitored on third grade curriculum based measure probes. This level may

not have been sensitive enough to change for some of these students. Additionally, there were no pre-test data available for the generalization measures to assess whether improvement varied based on method of delivery. Additionally, there were no measures of maintenance.

This study only involved use of computers and laptops compared to paper-pencil. Read Live is also available on iPad. Future research studies may evaluate how use of the iPad may influence student outcomes different. As technology continues to improve, there will be continue to be opportunities for studies evaluating the influence of method of delivery on student outcomes.

Contributions to Extant Research and Practice

The results from this study extend the body of research suggesting that intervention can be effectively delivered using technology such as computers (Baker & Torgesen, 1995; Christ & Davie, 2009; Dynarski et al., 2007; Gibson et al., 2014; Murray & Rabiner, 2014; Nicholson et al., 2000; Torgesen et al., 2010). It also extends the body of research suggesting that Read Naturally can be effective (Christ & Davie, 2009; Gibson et al., 2014; Hasbrouck et al., 1999). Additionally, the study, along with Martin and colleagues' (2014), begins to fill the gap regarding whether there is a difference in student outcomes based on a newer technological delivery of the intervention versus a more traditional format. Martin et al.(2014) conducted research comparing two programs that use different methods of delivery, but they did not use the same intervention for both. The current study aimed to compare method of delivery using the same program to control for other inferences, thus starting to fill the gap regarding comparing different methods of delivery.

The results of the current study extend the body of research suggesting that participation in Read Naturally intervention can result in typical to ambitious growth for at-risk readers. In this study, participants from an at-risk reader population approximated typical to ambitious growth in gain scores in ORF. Hasbrouck and colleagues (1999) found that students in a traditional format approximated typical or ambitious rates of achievement on ORF. This study provides evidence that students in the computerized format may also approximate typical or ambitious rates of achievement. The differences in ROI were not observed as predicted, but significant differences in gain scores and implementation integrity were observed for Read Live groups, which suggests that computer assisted interventions may be more useful because it saves personnel resources, may result in similar or better outcomes, and has dependable implementation fidelity.

Findings of the current study add to the body of research that suggests that the observation of satisfactory generalization takes longer to be achieved than short-term interventions. Gibson et al. (2014) found that while ORF and comprehension increased in both of the phases of the Read Naturally Software Edition intervention in their study, satisfactory generalization did not occur for most until the second phase of intervention was implemented. Christ and Davie (2009) also found that students did not show significant gains in comprehension over a brief 10-week period of intervention, and instead suggest that comprehension gains would be expected over more extended periods of implementation. In the current study, no baseline data on comprehension or vocabulary measures were available, so an analysis of improvement was not possible. However, there was no statistical difference in performance on vocabulary and comprehension

outcomes due to method of delivery. It is possible that these differences would take longer to be observed.

Despite the extant literature base that suggests enhanced motivation as a key benefit of utilizing computer and tablet based technologies in education (Bangert-Drowns & Pyke; Falloon, 2014; Godzicki et al., 2013; Malone, 1981; Nicolson et al., 2000), we did not observe statistically significant difference between groups for method of delivery on student engagement in this study. Student engagement in this study was measured through student self-report surveys. Students may have answered the questions in a way that they felt like they should, rather than what they truly thought. It is also possible that students equally enjoyed participating in both the interventions, because instructional opportunities were not frequently provided to students outside their classroom instruction. The opportunity to work in small groups during the intervention may have been positive experiences for all students in this study. Teacher and interventionist surveys were not included in this study, which may have portrayed a different picture where students in the computerized group were more animated toward the program than those in the traditional format (as anecdotally reported in this study). Students were also informally observed to be more on-task in the computerized format, and several students in the traditional format asked multiple times if they could switch to the computer version. This suggests that in future research, additional student engagement measures should be utilized such as formalized observation systems and teacher/interventionist surveys.

The results of the current study also add to the literature suggesting that the use of technological delivery methods for interventions can increase implementation fidelity.

Torgesen and colleagues (2010) asserted that computer technology has the capacity to provide highly specialization instruction and practice, that can be potentially implemented with relative low cost per seat and relatively high and consistent implementation integrity. Results of this study support this assertion that computer technology aids in implementation fidelity by having the steps in a locked in sequence; thus, preventing students from moving onto the next step or story until they complete each step of their current story. Fidelity of the implementation of intervention components can be harder to track with students using the traditional paper/pencil and audio format, as demonstrated in this study as students who used Read Naturally (traditional paper format) were more likely to have partially completed stories in their packets ($p=.007$, effect size= .70) than the students in the Read Live intervention group.

Additionally, the currently study builds on Christ and Davie's (2009) study of the Read Naturally Software Edition (RNSE) intervention in which observed gains for the experimental group were obtained with minimal resources, with minimal training and teacher support for implementation. Results from this study demonstrated the possibility for observed gains in settings where there are minimal resources, with short/limited intervention trainings, and minimal teacher support.

There is a significant amount of knowledge about reading instruction in the literature; however, as technological advancements continue to be made, more research will be needed looking at the effect of method of delivery on reading instruction. This study represents movement toward developing a research base that explores the effects of delivery method on reading instruction and intervention. The results are promising that computer assisted reading fluency interventions may be as effective as face-to-face

interventions for improving student outcomes, thus providing an option to preserve personnel resources for other teaching activities. As further research is conducted to identify benefits and use of technological advancement, more information will become available for schools and educators to make when choosing how to allocate resources.

APPENDICES

APPENDIX A

CONSENT AND ASSENT MATERIALS

Consent Form for Participation in a Research Study

University of Massachusetts Amherst

Researcher: Caroline M. Shackett, M.Ed.
Faculty Sponsor: Amanda M. Marcotte, Ph.D.

Study Title: Examining the Effect of Mode of Delivery of a Reading Fluency Intervention Using a Randomized Experimental Alternative-Treatments Design

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1. WHAT IS THIS FORM?
This form is called a Consent Form. It will give you information about the study so you can make an informed decision about your child's participation in this research study.

2. WHO IS ELIGIBLE TO PARTICIPATE?
Third graders whose reading scores are below the 40th percentile based on school benchmarking.

3. WHAT IS THE PURPOSE OF THIS STUDY?
The purpose of this study is to evaluate different delivery methods for an intervention for struggling readers with a focus on instruction and prevention.

4. WHERE WILL THE STUDY TAKE PLACE AND HOW LONG WILL IT LAST?
If you consent, your child will begin a reading intervention. They will have the chance to be selected to use Read Naturally on the computer, or use a traditional format with paper and audio tapes. Reading interventions are part of the normal school day curriculum. The only difference will be whether your child participates on the computer version or the traditional format. Progress monitoring data will be collected to monitor your child's growth and shared with your child's teacher. With your consent, the researcher will be given access to screening data and progress monitoring information that are not linked to your child's (de-identified) name for 10 weeks. It will not be connected to your child in any way.

The data collection portion of the study will involve collecting the de-identified progress monitoring data from the school for 10 weeks this fall (September until November).

At the end of the 10 weeks, your child will be asked to complete a survey that asks how they feel about
Read Naturally. All activities will occur in your child's regular classroom or your school's computer lab.

5. WHAT WILL YOUR CHILD BE ASKED TO DO?

Your child will be asked to work independently with teacher supervision on a reading program, either on a computer or with a paper/CD player format approximately 3 times a week for 30 minutes. As part of this they will read passages along with a model, practice silently, and then read independently. The computer program is the same as the traditional format, only delivered electronically.

At the end of the study, they will be asked to fill out a short survey that asks them how they felt about Read Naturally.

We will also ask your school administrators to report your child's demographic data to us including their gender, race, language status, special education status, and instructional supports. No information that we gather will be connected to individual students. We will only report demographics of the group as a whole. These data will not be used to identify your child in any way, but are necessary to reflect the diversity of students who participated in our study. We will work closely with the school's data manager to gather these data and protect the identity of your child and the school.

6. WHAT ARE THE BENEFITS OF BEING IN THIS STUDY?

The data gathered will be provided to the principal and the teacher to help guide instructional and curricular decisions and to better reading intervention and resource allocation in the school. The data will also be used to investigate the differences in method of delivery of reading intervention that has the potential of having benefits for many struggling students.

Read Naturally is an intervention program that is supported by research, and the intervention has the potential to improve the reading skills of those who receive it.

7. WHAT ARE THE RISKS OF BEING IN THIS STUDY?

As with any classroom activity, there is the possibility students may experience mild anxiety. While we inform you of this risk, this reading intervention is a typical classroom practice that is similar to many activities already completed by students in your child's school. You are just giving permission for their progress data to be used to examine these interventions.

The data will be de-identified, meaning no data will leave the school that can be traced to your child.

8. HOW WILL MY CHILD'S PERSONAL INFORMATION BE PROTECTED?

The following procedures will be used to protect the confidentiality of study records. The researchers will keep all study records (including any codes to the data) in a secure location

including a locked file cabinet and password protected computer. No data attached to student names will leave the school.

All electronic files (e.g. database, spreadsheets, etc.) will be password protected. Any computer hosting these files will also be password protected to prevent access by unauthorized users. Only the members of the research team will have access to the passwords.

At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format and neither your child, nor your child's school, will be identified in any publication or presentation.

9. WILL MY CHILD RECEIVE ANY PAYMENT FOR TAKING PART IN THE STUDY?

Your student will receive small tokens such as stickers and/or pencils at the end of the 10 weeks for participating in the study.

10. WHAT IF I HAVE QUESTIONS?

If you have any further questions about your child's participation in this study, we will be happy to answer them. If you have further questions about this project, you may contact Caroline Shackett (cshackett@educ.umass.edu or 518.860.3974). If you have any questions concerning your rights as a research subject, you may contact Dr. Amanda Marcotte (amarcotte@educ.umass.edu or 413.545.7055) or the Human Research Protection Office (humansubjects@ora.umass.edu or 413.545.3428).

11. CAN MY CHILD STOP BEING IN THE STUDY?

The use of the student data outside the normal scope of the school day is strictly voluntary. If your child decides they no longer agree to participate in the study or have their data used, they may discontinue the study. They may be required to continue in some form of reading intervention per the school's normal practice. There are no consequences of any kind if you or your child withdraws consent to participate.

12. VOLUNTARY CONSENT

If you want your child to participate in the intervention and give permission for their scores to be used as part of the project described above, please sign and return the form to your child's homeroom teacher. I understand that my child may still participate in other forms of reading intervention that are part of normal school procedures even if I do not consent to this intervention study in particular.

- -

By signing below, I am indicating that **<u>I do</u>** want my child to participate in the study and for my child's scores to be included in the study's data analysis.

_____

Student Name (Please Print)

_____ _____ _____

Parent/Guardian Signature Print Name Date

In addition, the researchers would like access to other information about your child that could be useful in our research findings (gender, race, language status, and special education status). Your child's scores and information will be completely de-identified. This data will be used in an aggregated form and will not be connected to your child.

Please indicate whether or not you agree to have your child's de-identified school data released to the researcher by checking the appropriate box.

☐ I agree to my child's school data (gender, race, language status, and special education status) being released to the researchers.

☐ I do not agree to my child's school data (gender, race, language status, and special education status) being released to the researchers.

_____ _____ _____

Parent/Guardian Signature Print Name Date

Script

Script for explaining the study to the students. Complete this, then go through the assent form.

We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about how students learn to read. You are being asked to join the study because your teacher thinks we can help you with reading.

If you agree to join this study, you will be asked to spend some time a couple days each week listening to a story, then practicing reading it, then reading it a loud to your teacher or another adult. Some of you will be reading from paper, and some of you will be using a computer. There are a bunch of different types of stories you can choose to read from. We will also have you read another short story a loud for 1 minute each week. At the end of the study, we will have you answer some questions about what you thought about the stories you read and the things you did. This will take place for two months (this fall).

Just like when you are reading, there may be times when it is hard for you to do. We hope that by doing this, reading will be easier and more fun for you! We may also learn something that will help other students with learning to read someday.

Your parent or guardian knows about this study and that we are asking if you would like to be part of it.
Before you say **yes or no** to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell your parent or the researcher that you have a question.

Assent Form

We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about how students learn to read. You are being asked to join the study because your teacher thinks Read Naturally might help you!

Some students will be randomly picked to use Read Naturally on the computer while others will u se paper and CD players.

At the end, we will ask you to answer some questions about how you like Read Naturally.Your parent or guardian knows about this study and that we are asking if you would like the chance to be in it.

Read Naturally can help you get better at reading. We may also learn something that will help other students and how they learn to read someday. This study will help us learn more about how students learn to read.

You do have to do the reading program your classroom uses. You do not have to join the study. It is up to you. You can say okay now and change your mind later. No one will be mad at you if you don't want to be in the study or if you join the study and change your mind later and ask to stop.

Before you say yes or no to wanting to be in the study, we will answer any questions you have. If you say yes, you can ask questions at any time. Just tell your parent, teacher or the researcher tha t you have a question.

If you want the chance to be selected to use the computer for Read Naturally, please write your name below.

Participant Name _____ Date _____
Name of Person Obtaining Assent _____ Date _____

APPENDIX B

IMPLEMENTATION FIDELITY MATERIALS

Group: _____ Date: _____

Read Naturally Masters Edition (ME) Fidelity Checklists

Use the Observation Checklist to monitor the set-up and implementation of Read Naturally Masters Edition (ME). Use the Follow-Up Questions Checklist to refine the implementation of the program to ensure maximum progress for each student. You can use these checklists as a self-review of your own implementation or use them as an observer to provide a starting point for conversation and coaching with another teacher. For detailed information about setting up and effectively implementing a program, see the *Read Naturally Masters Edition Teacher's Manual.*

Read Naturally ME Observation Checklist: What Should I See?

Observe a group of students using Read Naturally ME, and check each item below that is implemented correctly.

Planning and Setting Up

r Setting promotes students' engagement for entire session (location, room arrangement).

r Session length is 30–45 minutes.

r Students attend 3–5 sessions per week.

r Ratio of teachers/adults to students is no greater than 1:6.

Implementing the Steps *(Observe individual students.)*

r Select a Story step: The student selects a story from the set.

r Key Words step: The student listens to or reads along quietly with the audio for each key word.

r Prediction step: The student writes a prediction about the story.

r Cold Timing step: The student conducts a cold timing either with a teacher or independently.

During the cold timing, the student should always mark his or her own errors, and if a teacher is present, the teacher should coach the student on identifying errors.

r Graph Cold-Timing Score step: The student graphs his or her score in blue.

r Read Along step: The student reads the story quietly along with the audio.

r Practice step: The student practices reading the story aloud quietly until he or she reaches his or her goal. The student records his or her wcpm score for each timing.

r Answer the Questions step: The student answers the comprehension questions.

r Pass step: The student practices the story while waiting for a teacher. When a teacher is available, the student completes the hot timing. The teacher reviews the work completed on the story with the student. If necessary, the teacher assigns remedial actions.

r Graph Hot-Timing Score step: The student graphs hot-timing and comprehension scores in red.

r Retell/Word List step: In most series, the student retells the story. In the Phonics series, the student practices reading lists of words until he or she reaches the predetermined goal.

Student Behavior

r Students confidently follow the steps.

r Students use the CD players, headphones, and timers appropriately.

r Students' time on task is high. They complete the steps and pass a story in 30–60 minutes.

r Students spend most of the class time reading.

r Students know their goals

Group: _____ Date: _____

Read Naturally Live Fidelity Checklists

Use the Observation Checklist to monitor the set-up and implementation of Read Naturally Live. Use the Follow-Up Questions Checklist to refine the implementation of the program to ensure maximum progress for each student. You can use these checklists as a self-review of your own implementation or use them as an observer to provide a starting point for conversation and coaching with another teacher. For detailed information about setting up and effectively implementing a program, see the *Read Live User Guide.*

Read Naturally Live Observation Checklist: What Should I See?

Observe a group of students using Read Naturally Live and check each item below that is implemented correctly.

Planning and Setting Up

- Setting promotes students' engagement for entire session (location, room arrangement).
- Session length is 30–45 minutes.
- Students attend 3–5 sessions per week.
- Student-to-teacher ratio is no more than eight students per adult.

Implementing the Steps (Observe individual students.)

- Select a Story step: The student selects a story from the set.
    - Key Words step: The student clicks each key word and listens to or reads along quietly with the audio.
- Prediction step: The student types a prediction about the story.
    - Cold Timing step: The student plays Wordtastic while waiting for a teacher or independently conducts a cold timing. During the cold timing, the student should always click his or her own errors, and if a teacher is present, the teacher should coach the student on identifying errors.
- Read Along step: The student reads the story, vocalizing quietly along with the audio.
    - Practice step: The student practices reading the story aloud quietly until he or she reaches his or her goal and completes the required number of practices.
- Quiz step: The student answers the comprehension questions presented.
    - Retell/Word List step: In the Sequenced series, the student retells the story. In the Phonics series, the student practices reading a word list until he or she reaches a predetermined goal and completes the required number of practices.
    - Pass step: The student practices the story and plays Wordtastic while waiting for a teacher. When a teacher is available, the student completes the hot timing, and then the teacher evaluates the student's work from the Quiz and Retell/Word List steps. The teacher reviews the work completed on the story with the student. If necessary, the teacher assigns remedial actions.

Student Behavior

- Students confidently follow the steps.
- Students know how to use the software.
- Students' time on task is high. They complete the steps and pass a story in 30–60 minutes.
- Students spend most of the class time reading.

- Students know their goals.

APPENDIX C

OUTCOME MEASURES MATERIAL

Read Naturally Survey

Did you use the computer for Read Naturally?_____
Date_____

Directions:
Read the portions in italics aloud to the students.

Script For Administrators: *In order to get to know what you think about reading and Read Naturally, I am asking you to rate these different questions. First, write yes if you used the computer for Read Naturally or No if you did not and date on the top of your survey. I will read you some statements, and then you will think about it and circle the face that best fits what you think about the statement.*

If you very much agree, circle the really happy face. This means that this statement is something you might say and agree with very much.

If you pretty much agree, circle the just happy face. This means that you pretty much agree and this statement is something you might say.

If agree just a little bit, sometimes, or are unsure, circle the neutral face. This means I agree just a little bit, or don't know.

If you do not agree at all, circle the sad face. This means you do not agree with the statement at all, think it is not true, or is something you would never say.

Let's practice one! The statement is "I like pizza!". If you like pizza very much and agree with this statement, you would circle the really happy face. If you just like pizza and mostly agree with this statement, you would circle the happy face. If you sometimes like pizza, are unsure, or only like pizza a little bit, you would circle the neutral face. If you do not like pizza at all, you would circle the sad face.

Now that we have practiced and you know how to do it, let's move on to our questions about reading and Read Naturally. Are there any questions about what we are doing?

Directions for Administrator: Now read each statement one at a time for the group of students you are working with. You may move onto the next statement after all the students have made their selection.

At the end of the first set of statements, say:

Remember, if you very much agree, circle the really happy face. This means that this statement is something you might say and agree with very much.

If you pretty much agree, circle the just happy face. This means that you pretty much agree and this statement is something you might say.

If agree just a little bit, sometimes, or are unsure, circle the neutral face. This means I agree just a little bit, or don't know.

If you do not agree at all, circle the sad face. This means you do not agree with the statement at all, think it is not true, or is something you would never say.

Read Naturally Survey

Did You Use the Computer for Read Naturally?_____
Date_____

	Very Much	Pretty Much	Just a Little	Not at All
I like to read				
Reading is boring				
I like being read to				
Read Naturally has stories that are interesting to me				

I like being able to choose what story I am going to read				
I have fun while doing Read Naturally				
I want to try hard while doing Read Naturally				

Read Naturally Student Feedback Survey
Linda Butler and Linda Messer (n.d.) accessed from
http://www.readnaturally.com/knowledgebase/documents-and-resources/10/183

	Very Much	Pretty Much	Just a Little	Not at All
Read Naturally has improved my reading fluency (words per minute).				
When I read other books, I can tell I am improving because they get easier.				
I want to continue Read Naturally.				

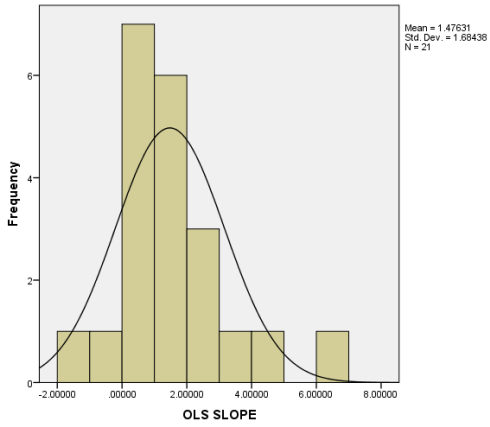
I am a better reader than I used to be.				
I am more willing to read out loud than I used to be.				
Read Naturally is easy to do.				
I would recommend Read Naturally to other students.				
Read Naturally uses interesting passages.				
I often learn interesting facts when I read the passages.				

APPENDIX D

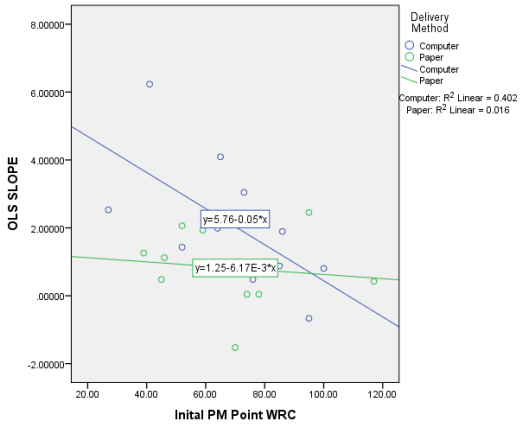
FIGURES

Figure A1. Visual Analysis of Distribution of Rate of Improvement

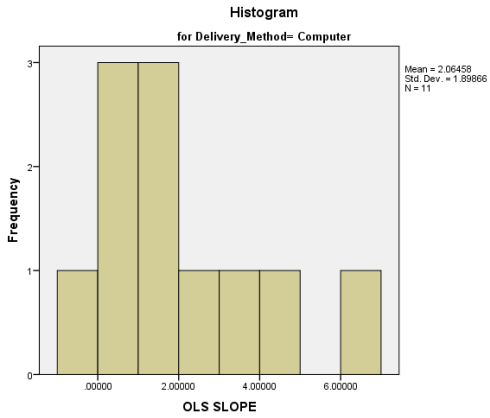
Histogram

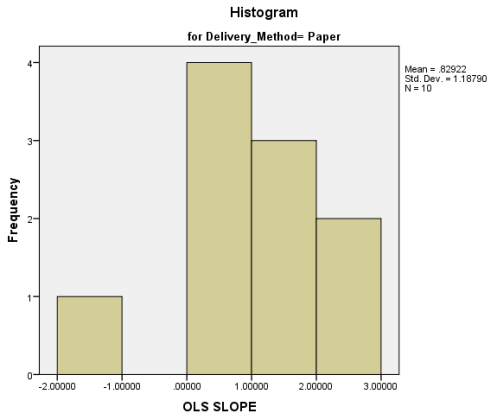


Scatterplot

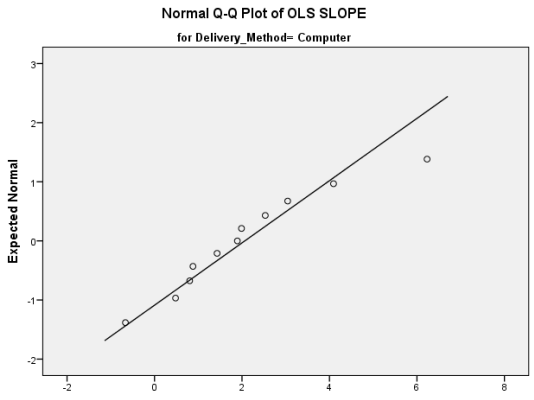


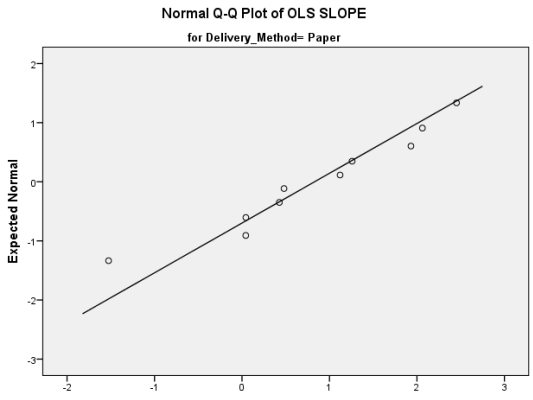
Histograms by Delivery Method





Normal Q-Q Plots by Delivery Method





Box Plot of Outliers for Rate of Improvement

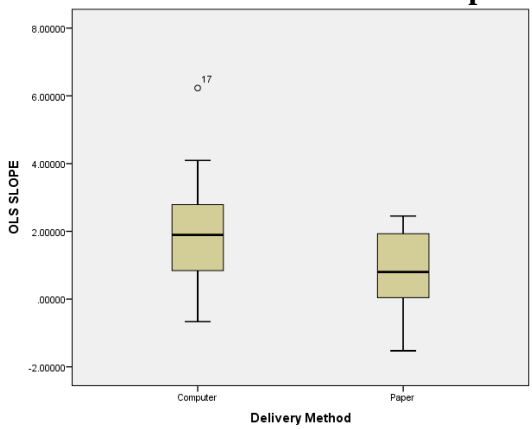
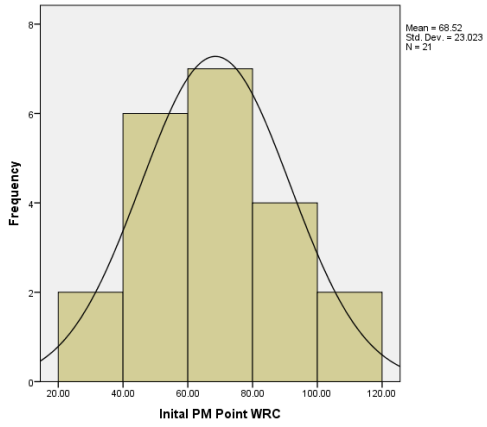


Figure A2. Visual Analysis of Distribution of Covariate

Histogram



Normal Q-Q Plot

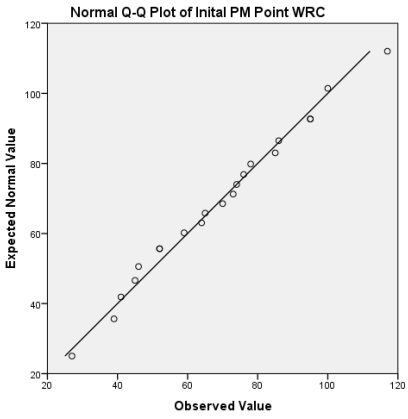
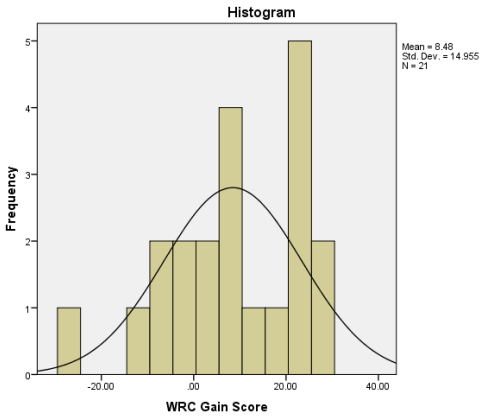
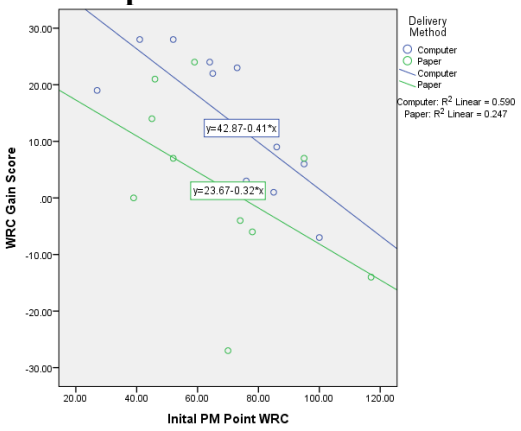


Figure A3. Visual Analysis of Distribution of Gain Score

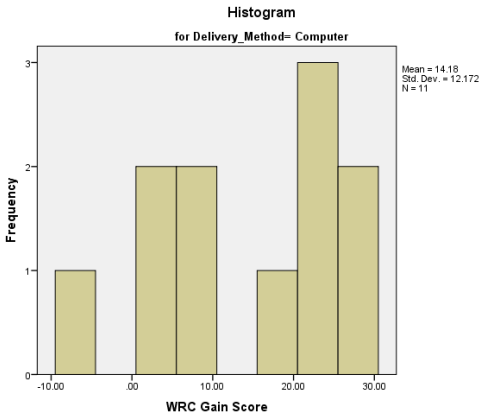
Histogram

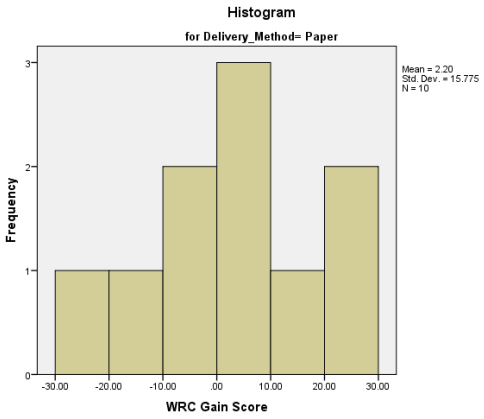


Scatterplot

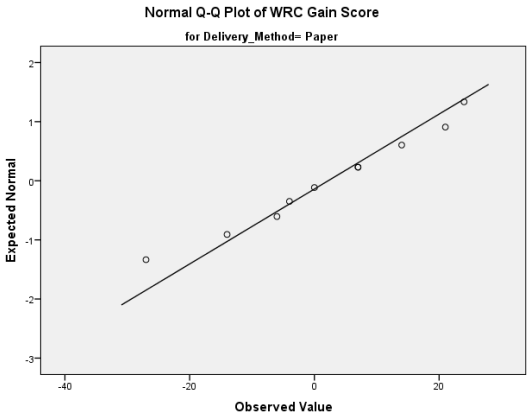


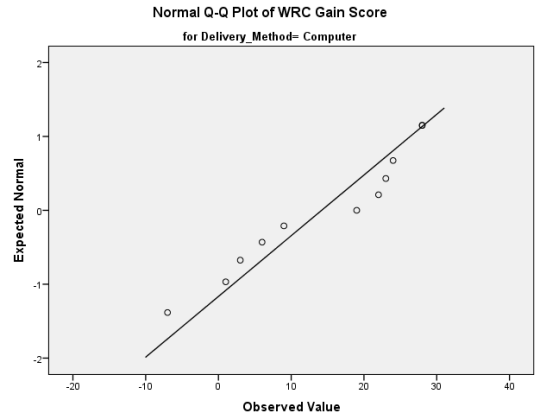
Histograms of Gain Scores by Method of Delivery





Normal Q-Q Plots of Gain Scores





Box Plot of Gain Scores

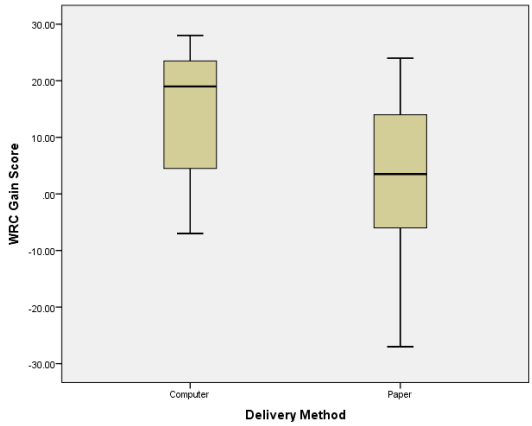
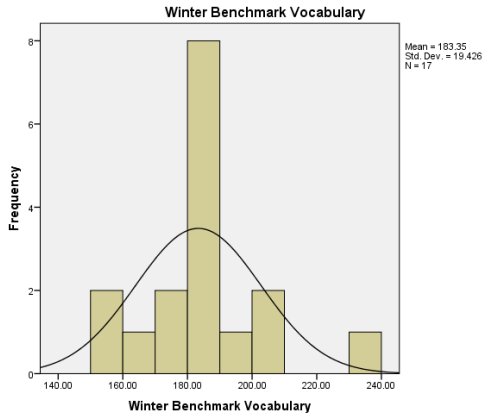
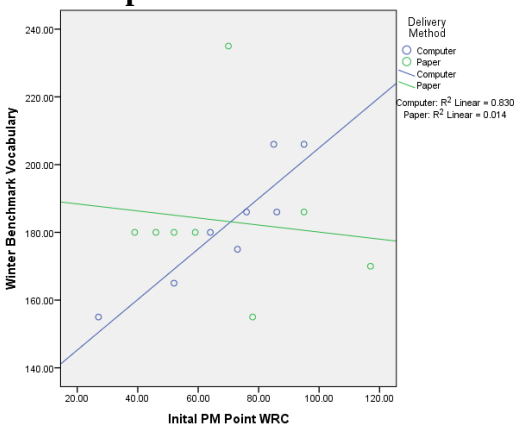


Figure A4. Visual Analysis of Distribution of Aimsweb Plus Vocabulary

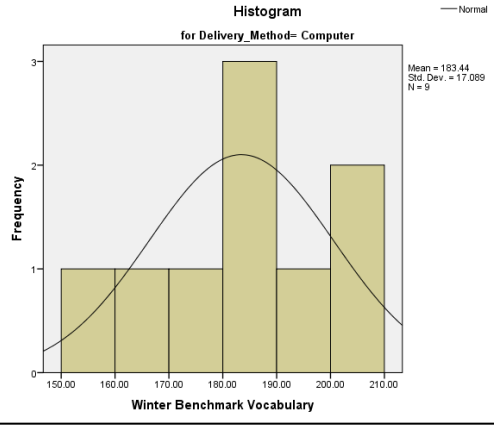
Histogram

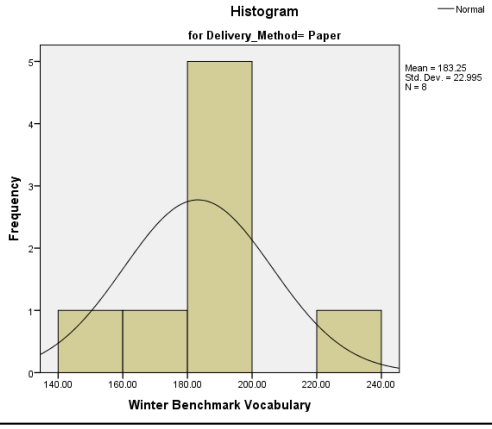


Scatterplot

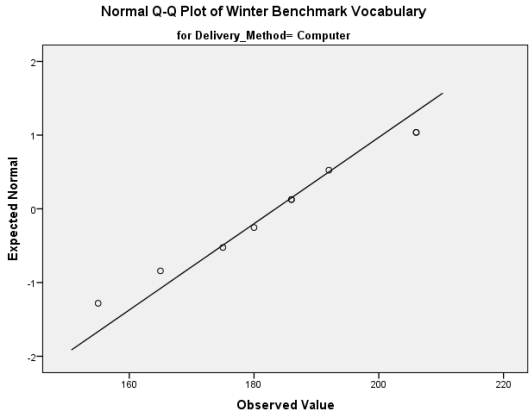


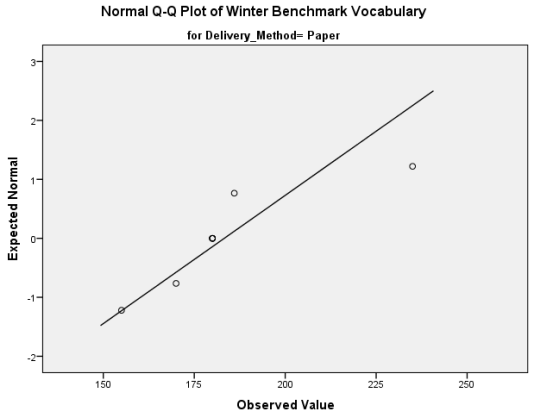
Histogram of Vocabulary by Method of Delivery





Normal Q-Q Plots of Aimsweb Plus Vocabulary





Box Plot of Aimsweb Plus Vocabulary

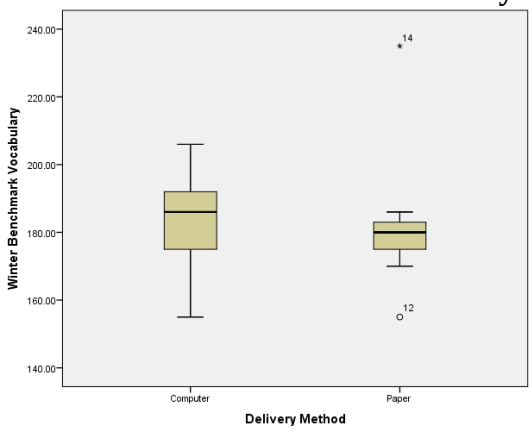
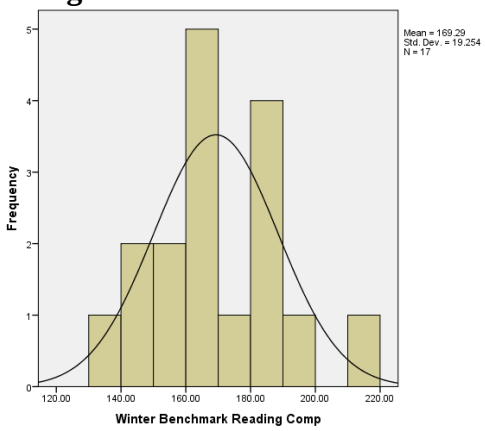
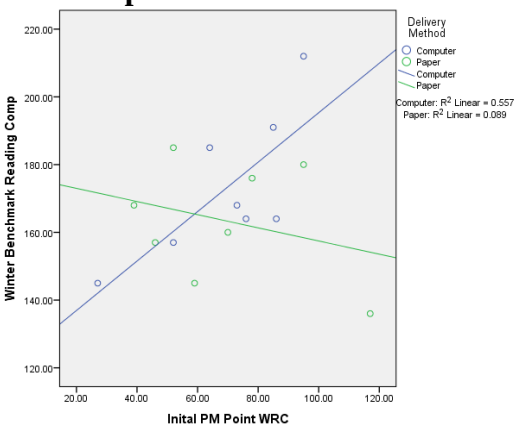


Figure A5. Visual Analysis of Distribution of Aimsweb Plus Reading Comprehension

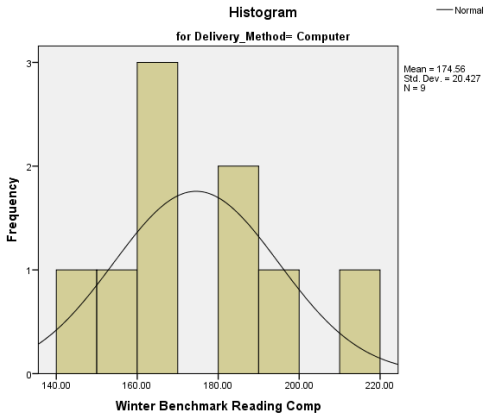
Histogram

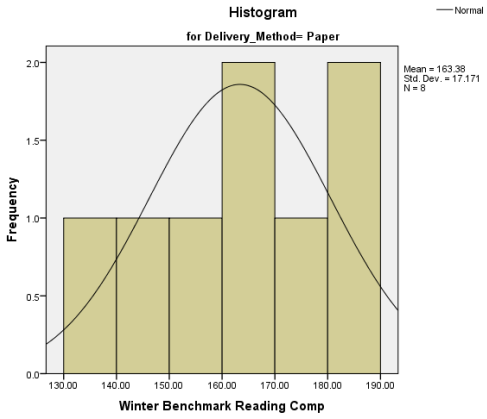


Scatterplot

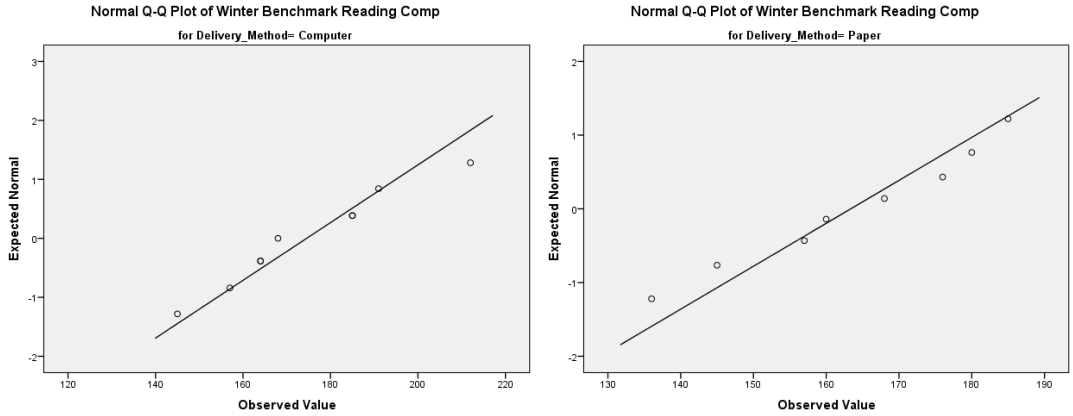


Histograms by Method of Delivery





Normal Q-Q Plots by Method of Delivery



Box Plot for Aimsweb Plus Reading Comprehension

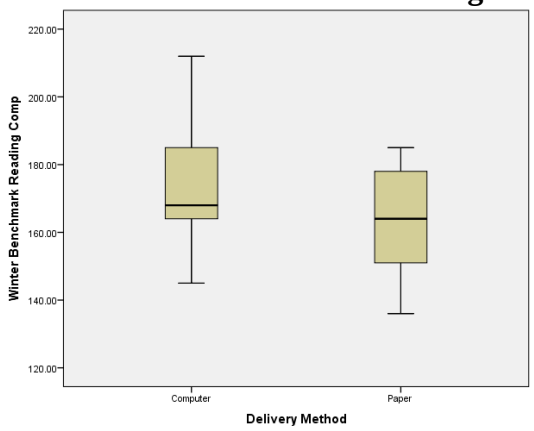
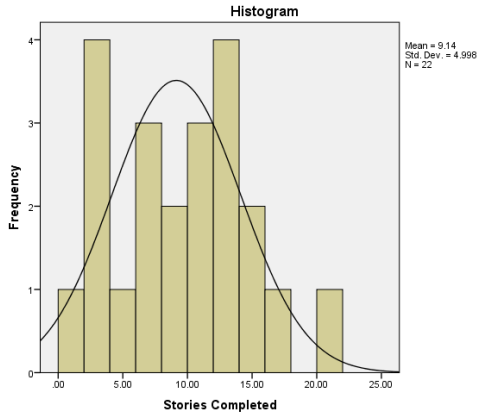


Figure A6. Visual Analysis of Distribution of Number of Stories Completed

Histogram



Normal Q-Q Plot

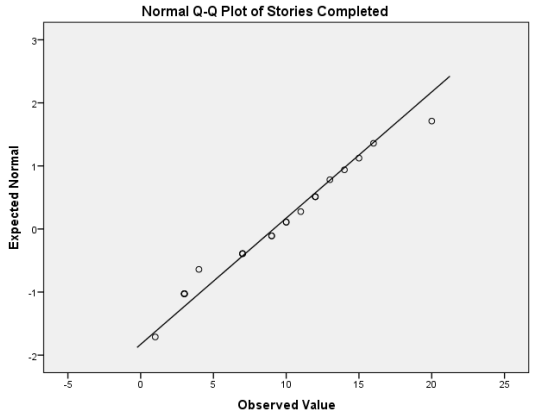
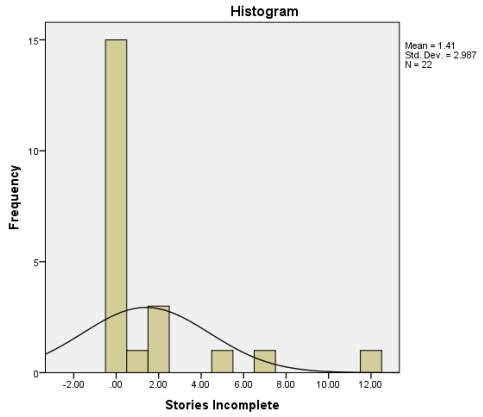
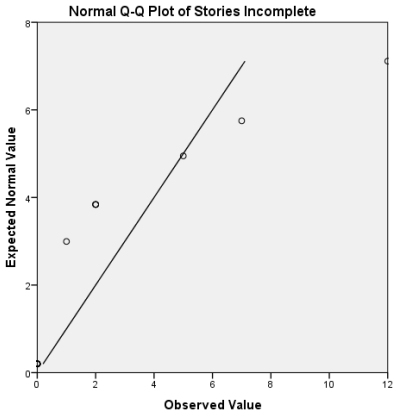


Figure A7. Visual Analysis of Distribution of Number Stories Incomplete

Histogram



Normal Q-Q Plot



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